GROWING PEACHES

SITES AND CULTURAL METHODS

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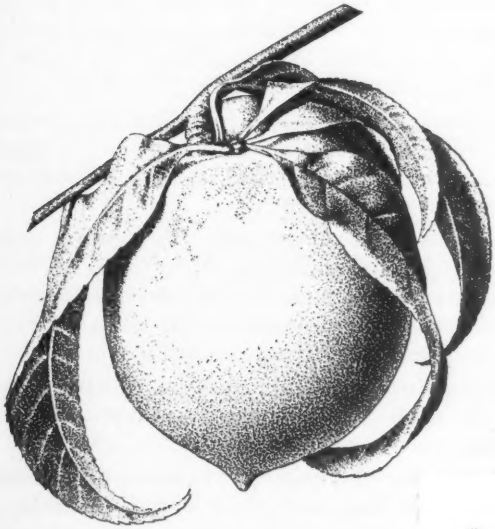

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WM. A. TAYLOR, Chief

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IN ITS commercial and economic importance in this country the peach is second only to the apple among deciduous-tree fruits. Commercial peach interests exist in about three-fourths of the States, with some home plantings in most of the others.

The peach grower who has had only limited experience will find in this bulletin information concerning some vital factors which largely determine the success of a peach orchard.

Emphasis is placed upon suitable location and site, because a faulty choice of either may be fatal to future financial success. Some mistakes in planning an orchard can be overcome as the orchard develops, but a poor location or site is beyond remedy.

The basic operations of planting, tillage, maintaining soil fertility, and pruning are discussed in this bulletin.

Spraying for the principal insects and diseases of the fruit is discussed in Farmers' Bulletin 440. Choice of varieties for planting in different regions is considered in Farmers' Bulletin 918. Both of these bulletins can be secured free of cost on request to the Department of Agriculture.

The present bulletin is a revision and combination of the two publications formerly issued as Farmers' Bulletins 631 and 632.

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DISTRIBUTION AND STATISTICS OF PEACH GROWING.

ALTHOUGH census figures of 1910 are nearly obsolete, there is no better way of showing the trend of the peach industry during the past generation, so far as the distribution of orchards is concerned, and its present extent, than by means of these figures, which are shown in Table I. Perhaps there is no more interesting deduction to be made from the figures than the widespread cultivation of the peach. In at least 39 of the 48 States there are peach interests of commercial importance. The limiting factor in the States where few trees are grown is doubtless extremely low winter temperatures. Yet in the milder portions of even these States, especially in protected locations, the growing of peaches is not an impossibility. It is obvious, however, that where the limit of possibility is approached, the number of crop failures may be expected to be large in comparison with the number of good crops.

Wide differences appear in the number of bearing trees in certain States in the different 10-year periods, some of which indicate a very large increase, while others show a large decrease in the peach industry. In some of the important peach-producing States in 1910 there were also nearly as many trees—in several instances considerably more—*not* of bearing age than of bearing age.

TABLE I.—*Distribution of peach trees,[a] by States, as shown by census reports.*

States.	Number of trees of bearing age—			Trees not of bearing age, Thirteenth Census, 1910.
	Eleventh Census, 1890.	Twelfth Census, 1900.	Thirteenth Census, 1910.	
New England:				
Maine	1,607	9,592	5,102	3,320
New Hampshire	19,057	48,819	57,571	35,213
Vermont	1,966	4,993	5,492	2,187
Massachusetts	87,004	301,405	154,592	162,114
Rhode Island	11,816	48,063	39,342	30,795
Connecticut	88,655	522,726	461,711	338,608
Middle Atlantic:				
New York	1,014,110	2,522,729	2,457,187	2,216,907
New Jersey	4,413,568	2,746,607	1,216,476	1,363,632
Pennsylvania	1,146,342	3,521,930	2,383,027	2,179,386
East North Central:				
Ohio	1,882,191	6,363,127	3,133,368	2,092,300
Indiana	953,980	2,925,526	2,130,298	1,145,479
Illinois	783,910	2,448,013	2,860,120	739,358
Michigan	1,919,104	8,104,415	2,907,170	2,991,090
Wisconsin	387	6,967	4,163	4,148
West North Central:				
Minnesota	334	1,626	1,571	3,837
Iowa	82,238	516,145	1,090,749	283,308
Missouri	1,999,474	4,557,365	6,588,034	1,404,429
North Dakota	.....	2	90	604
South Dakota	78	1,080	1,815	5,259
Nebraska	144,701	1,055,959	1,188,373	263,882
Kansas	4,876,311	5,098,064	4,394,894	620,709
South Atlantic:				
Delaware	4,521,623	2,441,650	1,177,402	212,117
Maryland	6,113,287	4,017,854	1,497,724	805,053
District of Columbia	1,521	149	330	1
Virginia	1,218,219	1,939,113	1,585,505	780,551
West Virginia	450,440	1,695,642	1,424,582	1,441,188
North Carolina	2,133,004	2,773,788	2,661,791	861,042
South Carolina	711,138	1,136,790	1,336,142	349,790
Georgia	2,787,546	7,668,639	10,609,119	1,531,367
Florida	235,936	354,208	290,850	156,762
East South Central:				
Kentucky	1,205,866	2,884,193	2,245,402	1,110,744
Tennessee	2,347,699	2,749,203	3,163,737	1,190,727
Alabama	1,280,842	2,690,151	3,177,331	838,866
Mississippi	878,569	1,856,748	1,726,298	724,895
West South Central:				
Arkansas	2,769,052	4,062,218	6,859,962	2,884,927
Louisiana	317,132	758,877	903,352	316,132
Oklahoma	206	[b] 5,848,808	4,783,825	2,574,680
Texas	4,486,901	7,248,358	9,737,827	2,958,813
Mountain:				
Montana	.....	1,670	538	3,386
Idaho	13,639	79,757	73,080	212,995
Wyoming	.....	9	46	419
Colorado	8,204	319,998	793,372	606,001
New Mexico	23,081	117,003	136,191	184,466
Arizona	24,954	67,073	51,415	32,562
Utah	68,121	409,665	544,314	651,233
Nevada	3,996	9,136	6,329	5,049
Pacific:				
Washington	72,701	226,636	536,875	1,028,141
Oregon	115,244	281,716	273,162	508,179
California	2,669,843	7,472,393	7,829,011	4,409,562
Total	53,885,597	99,916,598	94,506,657	42,266,243

[a] Includes also nectarines, but the number of nectarine trees is so small as to be practically negligible.
[b] Includes Indian Territory.

LOCATION AND SITE.

The location of an orchard has to do with its general surroundings. It may relate to transportation facilities, markets, climatic conditions, and the geographical position of the district or region in which an orchard is placed, or, in other words, its local geography. The

site has to do with the particular piece of land occupied by the trees. It relates to the soil, slope, atmospheric drainage, and other natural factors which affect the suitability of a given area of land for peach growing.

A location may have every natural advantage as to climate, soil, and other local conditions for the successful growing of peaches and yet, because of its remoteness from a shipping station, distance from suitable markets, or even the impracticability of supplying ice for refrigerator cars, it may be impossible to market them profitably. Moreover, a location may have all these advantages to a satisfactory degree and yet not be desirable for commercial peach growing because the markets within its logical radius for distribution are already abundantly supplied with peaches from districts which in some important respects are more advantageously placed.

FIG. 1.—A fairly typical peach-orchard site in the Allegheny Mountain district of West Virginia, this being in Morgan County. In many instances the soil and other conditions in the valleys between the ridges are not well suited for peaches, even though the ridges may be admirably adapted to them.

It is likewise true that within a district which as a whole is well located for commercial peach growing there may be and usually are sites which are not adapted to this purpose, for reasons that are entirely local. This is especially apt to be the case in mountainous districts or wherever the topography is much broken and soil conditions are very variable. Especially careful discrimination in the selection of sites for orchards is essential in such districts. Figures 1 and 2 show typical orchard sites in important peach-growing districts in mountainous sections in widely separated parts of the country.

SITES WITH REFERENCE TO SOIL.

It is the current opinion that the peach should be planted on sandy or some of the lighter types of soil. Excellent results may follow the planting of orchards on such soils, but peaches do well also

on a wide range of soil types, including even some of the moderately heavy clay loams and clays. But whatever the type, a soil must be thoroughly well drained. Peaches will not succeed on poorly drained soils. The heavy clay types which are so hard and impervious that water does not percolate through them readily are to be avoided. Moreover, the soil should be moderately fertile. One very rich in nitrogen is not desirable as a general rule, since it may induce an excessive growth of foliage, but the impression that a poor, infertile soil is "good enough for peaches" is erroneous.

Where alkali soils occur, they should be avoided. While the peach tree can be grown where there is a limited amount of the alkali salts, they cause disaster if present in large quantities. It is safer, therefore, to avoid them as far as possible.

FIG. 2.—A fairly typical peach-growing section in a foothill district in California, this being in Placer County. Though the surface is much broken, these orchards are all irrigated.

SITES WITH REFERENCE TO ELEVATION.

Generally a site that is elevated considerably above the surrounding areas is to be preferred for a peach orchard. Cold air settles to the lower levels. For this reason it is often colder at the lower elevations than it is at higher points. This is what is meant by "atmospheric drainage." The occurrence of frost in low places when there is none on elevated areas is thus explained. For the same reason peach buds are often winterkilled or the blossoms are injured by frost in the spring in low places when near-by orchards on higher elevations are injured much less, or even escape entirely. During the past few years the importance of selecting relatively high sites for peach orchards in order to avoid the effects of unfavorable temperatures has been emphatically demonstrated in many different parts of the country. There are, however, certain general exceptions to the foregoing statement. Where an orchard that is well elevated above the surrounding country is exposed to low temperatures which are accompanied by severe winds, the fruit buds

are sometimes injured, when in the orchards at lower levels in the same locality, where there is protection from the wind, no injury occurs. However, injury under these conditions is rather rare in comparison with that which occurs in orchards that occupy relatively low sites.

SITES WITH REFERENCE TO BODIES OF WATER.

Where an orchard has a site adjacent to a body of water of sufficient size and depth to have an appreciable influence on the local climate, the importance of a relatively high elevation largely disappears. Because water warms up in the spring more slowly than the atmosphere, it acts in effect as a refrigerator, making the temperature in its immediate vicinity colder than at points somewhat distant from it. Vegetation within the zone of this influence advances more slowly in the spring than it does outside of that zone. The tendency is for the blossoming of peach trees within the zone to be delayed until after the season of spring frosts is past.

In the fall, frosts are delayed. The water, having absorbed much heat during the summer, cools off in the fall more slowly than the atmosphere and tends to keep the temperature within its zone of influence warmer than it would otherwise be.

For these reasons peaches are grown with marked success in the portions of New York and the Province of Ontario that border Lake Ontario; in Ohio along Lake Erie; in southwestern Michigan on Lake Michigan, and in some other districts adjacent to large bodies of water. The influence of such bodies of water usually does not extend back from the shore more than a few miles, though the slope of the land with relation to the water determines largely the extent of the area affected.

SITES WITH REFERENCE TO SLOPE.

The slope or exposure of a site has reference to the point of the compass toward which the land inclines. No one slope is preferable under all conditions and in all regions. A site having a moderate slope in some direction probably is to be preferred for orchard purposes to one that is level, as one with a slope will usually have better soil and atmospheric drainage than a level area; but one slope may be as good as another.

An orchard that occupies a site which slopes away from the prevailing wind may be afforded a certain amount of protection therefrom, and in some regions there are well-marked soil differences on the different slopes of the ridges. These differences may be such as to make one slope better adapted to peach growing than another.

The slope factor, however, is largely one of degree. Peach trees on a site having a very steep southern slope will usually blossom and

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the fruit will ripen somewhat earlier than on a corresponding northern slope, but where the differences in slope are only moderate their relative influence on the time of blossoming and ripening is not very marked. Whether early or late blossoming is desirable is largely a local matter and depends primarily on the relative dates of blossoming and the usual occurrence of spring frosts in any locality or on any site.

TEMPERATURE A LIMITING FACTOR.

Aside from economic factors, temperature probably is the most decisive limiting factor in the distribution of commercial peach growing. Usually the fruit buds are the first to suffer injury. No absolute minimum temperature which the peach is able to withstand without injury can be given. The condition of the buds with regard to their strength, vitality, and perfect dormancy, the duration of the critical temperature, the climatic conditions following the cold period, perhaps the amount of moisture in the air during the period, and other factors all have an influence.

In many peach districts, however, the growers are always apprehensive of injury, even with buds in good condition and all other factors favorable, whenever the temperature reaches 10° to 20° F. below zero, though buds of many varieties often withstand temperatures considerably lower than this when all other conditions are favorable.

Where severe spring frosts occur from year to year during the blossoming period it is not practicable to produce peaches on a commercial basis. Similarly, regions in which protracted warm periods occur from time to time during the winter have usually proved to be uncertain for peaches. The trees become more or less active during the warm periods; the buds start enough to become tender and are injured later even by temperatures which may not be unseasonable for the latitude. For this reason winter and spring injury is sometimes experienced in middle and southern latitudes, when peaches in the northern districts escape.

Orchard heaters offer a measure of relief under some conditions in districts subject to unseasonable spring frosts, but such districts are, nevertheless, seriously handicapped in comparison with those where disastrous frosts rarely occur.

PROPAGATION OF PEACH TREES.

The average peach grower is not concerned directly with the propagation of trees. It is generally more advantageous for him to purchase them from one who makes the growing of trees his special business than to grow them himself. However, the general features of propagation should be understood by those engaged in peach growing. They are, therefore, briefly outlined in the present connection.

The site selected for a peach nursery should be one that is well drained and where the soil is preferably rather light, though not necessarily sandy. It is important also that the soil should be rather rich, in order to insure as far as possible a satisfactory growth of the trees.

The details of propagating the peach begin with the pits or seeds from which the stocks are grown and on which the different varieties are budded. The pits are obtained by nurserymen from many different sources. They are handled in different ways, depending quite largely upon climatic conditions, the extent of the business, and other factors.

In the middle latitudes, where probably the largest peach nurseries are located, the pits are generally planted in the fall in rows 3 to 4 feet apart where the trees are to be grown. In the North the pits are sometimes stratified or bedded in the fall in moist sand, where they are under some degree of control, and the planting is delayed until spring. In either case, the action of the moisture and freezing temperatures results in the cracking of the "stones." If the pits have been stratified, the kernels are usually sifted from the stones and sand before planting. They are then handled in essentially the same manner as pits that are planted in the fall.

In very mild climates where there is little action from frosts or freezes, it is probably quite important to prevent the pits from ever becoming dry. If they are not planted as soon as they are removed from the flesh of the fruit, they should be held in such a manner as to prevent the loss of much moisture. Otherwise, a very slow and irregular germination would follow. However, pits that have become dry will frequently germinate fairly well without freezing, provided they are soaked in water for a sufficiently long time before being planted.

The usual method of propagation is by budding,[1] and the seedlings should be large enough to bud by midsummer in their first season's growth. This is done largely during July and August, extending sometimes into September. The buds put in during these months should "take," that is, become attached to the stock, within a comparatively few days if the operation is successful; then they should remain dormant until the following spring. After the buds "take," it is a common practice to "lop over" the tops of the seedling stocks by cutting them nearly off just above the point where the bud was inserted. Subsequently, the tops are entirely removed, or the tops may be left until the following spring and then removed without being previously lopped over.

The trees are ready to be planted permanently in the orchard after they have made one season's growth in the nursery. These are

[1] The operation of budding is fully described in Farmers' Bulletin 157, entitled "The Propagation of Plants," a copy of which will be forwarded without cost on application to the Secretary of Agriculture.

known as "1-year-olds," and they comprise the great bulk of the trees that are delivered by nurserymen for fall and spring planting.

A limited amount of budding is done by some nurserymen in June. Buds inserted as early in the season as this are expected to start into growth with but little delay instead of remaining dormant until the next spring, as is the case with the buds that are put in later in the summer. The trees so grown are termed "June buds" and are ready for permanent planting the following fall. While some growers plant this grade of tree with a high degree of success, the majority prefer 1-year-old trees, as already stated. Trees older than one year should not be planted unless in very exceptional instances.

In California, the stocks which are budded during the summer are sometimes used the following fall and spring for planting orchards. This practice is commonly referred to as "dormant-bud" planting.

REGIONS FROM WHICH TO OBTAIN TREES.

The section of the country from which trees are obtained is unimportant so long as the trees are well-grown, healthy, and typical of the desired varieties. The growing of good trees depends upon favorable conditions and proper management in the nursery, and these factors are not peculiar to any particular section.

The inherent qualities of a variety do not change when the trees are grown in different sections of the country. If the variety is hardy, it will continue to be so; if it is susceptible to some disease, it is not made less so by growing the tree during its nursery period in some particular region.

For economy in transportation trees should be purchased as near the place where they are to be planted as practicable. Moreover, trees shipped long distances sometimes suffer injury if they are not properly packed or if they pass through severe extremes of temperature while in transit. Other things being equal, the nearer the nursery the shorter the period during which the trees are out of the ground. On the other hand, differences in the price of trees of the same grade offered by different nurserymen, the desire to secure trees of some special varieties, or some other reason may make it preferable to purchase elsewhere than at the nearest nursery.

TREES FOR PLANTING.

As a rule, only thrifty, well-grown, well-rooted 1-year-old or "June-budded" trees free from injurious insect pests and fungous diseases should be planted. Thrifty, well-grown trees are not necessarily the largest trees which can be found in a nursery. Medium-sized trees are probably fully as desirable for planting as the larger ones, but the smaller grades in some cases may be made up of trees

that are stunted and weak from some cause or other. Not infrequently they have poor root systems. The smaller trees can usually be bought at a lower price than the medium-sized and large ones, but they may prove costly in the end, especially if they are lacking in vitality and make a poor growth after being planted.

Peach trees are commonly graded according to their height. In properly grown trees, however, there is a pretty definite relation between the height and the size of the trunk or "caliper" of the tree. The diameter of the stem is sometimes used as the basis for grading nursery stock. The grades, according to height, are designated as "3 to 4 foot," "4 to 5 foot," "5 to 7 foot" trees, etc. Figure 3 shows four trees of each of three different sizes or grades. The relative size and height are apparent. The heaviest grade (C) is composed of larger, more heavily branched trees than the smaller ones; but they are more bulky and heavier to handle, and it is a question whether they will develop into any better trees ultimately than the medium-sized grade. The smallest grade (A) is composed of fairly good trees, but some of them may be lacking in vitality. Sometimes, for the sake of reducing the first cost, a grower buys even smaller trees than the 3 to 4 foot grade, but in most cases this proves to be false economy. A few cents per tree of additional cost means comparatively little in the initial expense of starting an orchard, but it may mean a vast sum later in the life of the orchard in the better development of good, vigorous trees.

Before planting an orchard, every prospective peach grower who has important interests at stake should form an accurate conception of what constitutes good nursery trees in every respect; he should thoroughly familiarize himself with the appearance of the insects and diseases that are likely to be disseminated on nursery stock; and he should give particular attention to the character of the roots and their freedom from such troubles as crown-gall and aphis injury.

TIME OF PLANTING.

In general, in northern latitudes, or wherever the winters are rather severe, planting in the spring as early as the soil can be worked to advantage and after the danger of hard freezes is past is to be advised. But in middle and southern latitudes and in regions generally where the winters are mild and where the fall season is favorable for working the soil until late, the planting of trees in the fall is generally successful and by many is preferred to spring planting. The planting should be delayed until thoroughly well and naturally ripened trees can be obtained, but it should be done before the advent of really cold weather. Fall-planted trees should reestablish some root action in their new positions before winter sets in. The danger of winter

injury is thus reduced. But in some of the milder portions of the country, where the soil seldom freezes deep and rarely remains frozen for more than a few days at a time, peach trees are commonly planted at almost any time during the winter.

In many parts of California, after the first rains have moistened the soil, usually early in January, the planting may be done to advantage, though some soils may be too cold and uncongenial at that

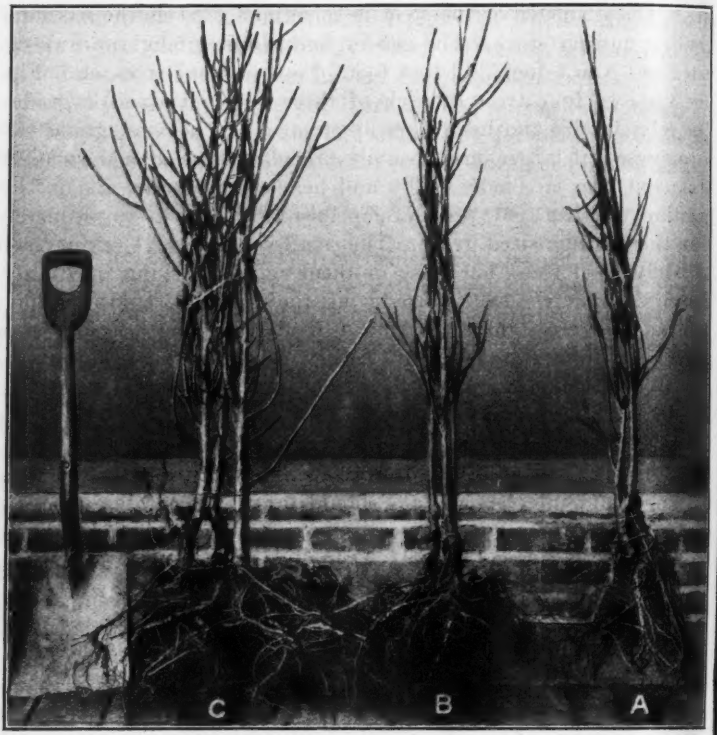

FIG. 3.—Nursery stock, showing different grades or sizes of 1-year-old peach trees: *A*, 3 to 4 foot grade; *B*, 4 to 5 foot grade; *C*, 5 to 7 foot grade.

time. In such cases planting is usually deferred until early spring, though there is then some danger of the trees starting into growth before the soil reaches a suitable condition to be properly handled.

HANDLING THE TREES WHEN RECEIVED FROM THE NURSERY.

When received from the nursery the trees should be unpacked immediately. Every possible precaution should be taken to prevent the roots from becoming dry. Unless the trees can be planted im-

mediately, they should be heeled in, in a thoroughly well-drained place, where the soil is mellow and deep. A trench sufficiently wide and deep to receive the roots is made; then the trees are placed in it in the manner shown in figure 4. In covering, the soil should be worked among the roots of the trees sufficiently to fill all the spaces between them. This will fully exclude the air; otherwise, there is danger of the roots drying unduly. If a large number of trees are to be heeled in at the same place, it will usually be found convenient to place them in closely adjacent rows. When this is done, the trees in one row, for convenience, may be covered with the soil which is removed in opening the next adjacent trench.

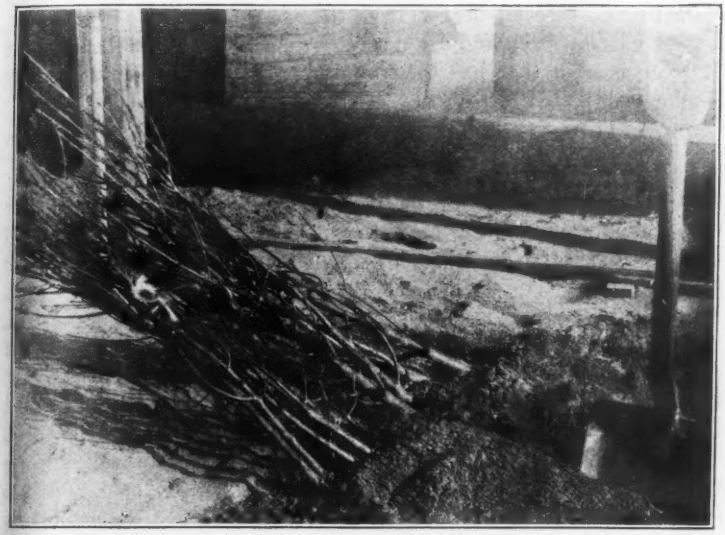

FIG. 4.—Peach trees heeled in. They may be held in this manner in good condition for a long time.

Trees that are tied in bundles when received must be separated before being heeled in. If this is not done, it is practically impossible to work the soil among the roots sufficiently well to prevent them from drying to a serious extent.

Sometimes it is necessary to leave the trees heeled in over winter. It is then well to place them in a position which is nearly horizontal, so that the entire portion of the trunks below the branches can be readily covered with soil for the purpose of protection. Such protection is of particular importance in the colder peach-growing districts. The soil should be made rather firm about the trunks and roots, so that harbors for mice will be reduced to a minimum.

PREPARATION OF THE LAND.

The ideal preparation of the soil for peach trees consists of deep plowing and thorough pulverizing with the harrow or cultivator, though a certain amount of variation from this ideal may not result disastrously. For example, where newly cleared land is to be devoted to peaches, it is practicable to remove the stumps from a narrow strip along the line of each row of trees, thus making possible a thorough preparation of the strip before the trees are planted and permitting thorough tillage throughout the following season. Each season thereafter the cleared strip should be widened and the cultivation extended. By the time the trees come into bearing, the stumps should be pretty well cleared from the entire area.

Newly broken sod land can not be as readily fitted for the planting of trees as land that has been plowed long enough for the sod to become well rotted.

PLANTING THE TREES.

Peach trees are planted at various distances apart, the topography of the land, the fertility of the soil, the varietal characteristics of the trees, and the preferences and conceptions of individual growers all being factors to be considered. Common planting distances are 18 by 18 feet, 18 by 20 feet, or 20 by 20 feet, requiring, respectively, 134, 121, and 108 trees per acre. Closer planting is sometimes practiced, but it is rarely advisable, and under some conditions 25 by 25 feet probably does not allow the trees more space than they need. The trees are usually planted in squares, as the above distances suggest, but the triangular system or some of its modifications is occasionally used.

Every reasonable care should be observed to plant the trees in straight rows and in perfect alignment in both directions. Trees so placed look better and can be cultivated better and more conveniently than where the rows are crooked and irregular.

Before digging the holes for the trees, some growers plow one or two deep furrows along the line which marks each row, thus greatly reducing the amount of digging that must be done with a spade at the points where the trees are to stand. The holes should be broad enough to admit the roots without bending or crowding them from their natural positions, and deep enough to allow the trees to be planted 2 or 3 inches deeper than they were in the nursery.

The use of dynamite in preparing the holes where trees are to be planted has been extensively advocated, but if a soil is well suited to peach growing, it is a question whether dynamiting will improve it materially. If the soil is not adapted to peaches, it is a question whether dynamiting can accomplish any permanent good. Moreover, under some soil conditions positive harm may result.

In some sections a thin stratum of hardpan or other impervious material occurs below the topsoil, while the subsoil beneath the impervious stratum is well suited to peach growing. Undoubtedly the use of dynamite as a means of breaking up such strata is entirely practicable and effective when it is properly applied.

In preparing a tree for planting, all portions of the roots which have been mutilated in digging the trees or injured by any other means should be trimmed off, and long slender roots, if they occur,

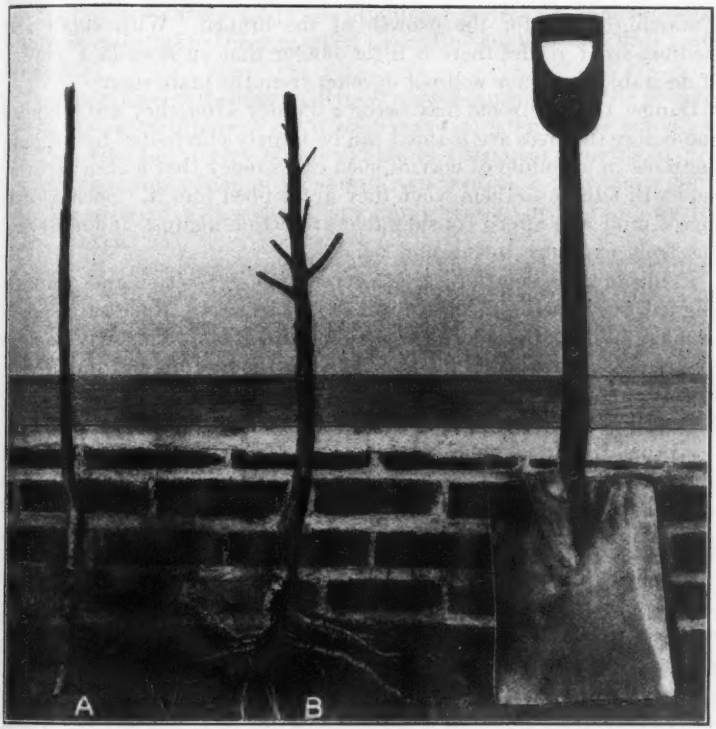

FIG. 5.—Peach trees trimmed ready to plant: *A*, 4 to 5 foot grade; *B*, 5 to 7 foot grade.

are usually cut off to correspond with the length of the general root system.

Unless a tree is rather large, the branches should all be removed, leaving only a single unbranched stem, as shown in figure 5, *A*. This stem should be headed back to correspond with the height at which it is desired to form the head of the tree. The common extremes as to height of top preferred by different growers range from about 12 to 18 inches up to 24 or 30 inches.

But if the larger grades are planted—those, for instance, which are 6 feet or more in height—it is usually safer not to trim to a single unbranched stem. There might, then, not remain enough buds which would give rise to branches properly placed to make a good symmetrical head. It is therefore wise to select from three to five branches that are well distributed about the main stem, from which to develop the head. The limbs thus selected for the foundation of the top should be headed back to mere stubs, as shown in figure 5, *B*, but on each stub there must be left at least one well-developed bud to insure a starting point for the growth of the branch. With small and medium-sized grades there is little danger that an abundant growth of desirable character will not develop from the main stem.

Danger that the roots may become too dry after they are trimmed and before the trees are planted can be largely eliminated by dipping the roots in a puddle of clay of such consistency that a thin layer of mud will adhere to them when they are dipped into it. Such a coating of mud will afford considerable protection against undue drying out from exposure to sun and wind.

In filling the hole after a tree has been put in position and properly aligned, only finely pulverized soil should be used. Much care should be taken to work the soil in closely about the roots. This may be done to some extent with the fingers. Moving the tree up and down very slightly after the first few shovelfuls of soil have been placed in the hole will also help materially to settle it among the roots.

As the filling progresses, the soil should be firmly tamped about the roots either with the feet or with some sort of a plunger. The soil around the tree should be left about even with the general level of the surrounding surface.

TILLAGE.

Tillage refers to the working of the soil after the trees are planted. The objects of tillage have been comprehensively summarized as follows:[1]

(1) Tillage improves the physical condition of the land (*a*) by fining the soil and thereby presenting greater feeding surface to the roots; (*b*) by increasing the depth of the soil and thereby giving a greater foraging and root-hold area to the plant; (*c*) by warming and drying the soil in the spring; (*d*) by reducing the extremes of temperature and moisture.

(2) Tillage may save moisture (*e*) by increasing the water-holding capacity of the soil; (*f*) by checking evaporation.

(3) Tillage may augment chemical activities (*g*) by aiding in setting free plant food; (*h*) by promoting nitrification; (*i*) by hastening the decomposition of organic matter; (*j*) by extending these agencies (*g*, *h*, *i*) to greater depths of the soil.

[1] Bailey, L. H. The Principles of Fruit Growing, p. 139. New York and London, 1897.

If the tillage is sufficient to maintain the physical condition of the soil and to conserve the soil moisture adequately, the other objects also probably will be realized. An orchard should be tilled, if at all, for the sake of the trees and their product. If without tillage the proper soil conditions exist to an extent which is adequate for the needs of the trees and the production of good crops, then perhaps nothing is to be gained by tillage.

With reference to peach orchards, there is comparatively little difference of opinion in regard to tillage. The conviction of the best growers in practically all peach-producing sections is that thorough tillage is essential to the continued successful maintenance of a peach orchard.

To one grower "thorough tillage" may mean plowing the orchard in the spring and harrowing it once or twice later in the season; to another, who has a very high estimate of tillage as a means of preventing the evaporation of moisture from the soil, it may mean going over the orchard with some tillage implement 20 or 25 times during a dry season.

Generally speaking, a peach orchard should be tilled throughout its entire life, beginning with the first season after the trees are planted. If, for the sake of economy or for other reasons, it is impracticable to work the entire area between the trees, it is usually feasible to confine the tillage for the first year or two to a narrow strip along each row. But the width of the tilled strip should be extended each season, and by the third year the entire surface should receive attention. By that time the roots of the tree extend beyond the spread of the branches and the entire space between the rows, where the trees have been planted the usual distances apart, is rapidly becoming filled with small rootlets and root hairs through which moisture and plant food in solution are taken up. The root development of peach trees, indicating the position of the roots with regard to tillage and the application of fertilizers, is suggested in figure 6.

Under normal or standard conditions in most peach-growing districts the advice applies generally, to begin the tillage in the spring as soon as the soil is in suitable condition to work. But in the case of bearing orchards, some of the most experienced growers wait until after the fruit has set before they begin, in the belief that earlier tillage may influence adversely the setting of the fruit. The presence of a cover crop, its character, and the needs of the soil with reference thereto are other factors that may influence the date of beginning of tillage. The handling of cover crops is discussed on another page.

If the soil is hard or if there is a cover crop that has made considerable growth, it will be necessary to turn the soil with a plow and

follow with a harrow, cultivator, or such other tillage implement as best suits the needs of individual orchards. If the soil is light, plowing in the spring can sometimes be omitted, as some type of cultivator will be found adequate to pulverize thoroughly the soil to a sufficient depth. The surface should be kept as nearly level as possible. For instance, if the soil is plowed toward the trees at one time, it should be turned away from them at a later plowing.

In general, the orchard should be gone over with some kind of a tillage implement often enough to keep the soil thoroughly light and

FIG. 6.—A peach tree about 5 years old growing in "Porter's red clay" soil, Virginia. The spread of the branches was 18 feet. The spread of the roots, as traced, was 36 feet—17 feet on one side and 19 feet on the other.

loose, or, in other words, in the condition of a dust mulch, for a depth of at least 3 or 4 inches. If a crust forms on the surface, or if the dust mulch becomes compact, evaporation of the moisture that is in the soil will become excessively rapid and an unnecessary and perhaps serious loss of moisture which is needed by the trees will occur. As the surface is made compact by rain, tillage is advisable, as a rule, after each rainy period or after heavy showers; also as much more frequently as the impaired condition of the dust mulch may make necessary. In irrigated orchards tillage should generally follow soon after each application of water.

Tillage operations are usually continued until midseason—the last of July or the first of August. By that time the growth of the trees

for the season will have been largely made, fruit buds for the next season's crop will have begun to form, the fruit of the midseason varieties will have completed a large proportion of its growth, and the later varieties will finish their development during a period when less moisture is required for the various functions of the tree than earlier in the season. Where cover crops or green-manure crops are desired, they should be sowed, in many cases, by this time.

As the trees become large, some of the extension types of tillage implements are advantageous, as they make possible the working of the soil under the branches without unduly crowding the team into the trees. In one of the large mountain peach orchards in West Virginia, where the broken topography of the land requires strong

FIG. 7.—An efficient outfit for the tillage of orchards where the topography is much broken and the draft is heavy.

motive power for efficient work, the outfit shown in figure 7 has proved especially well adapted. The team of leaders is driven by a "jerk line," the driver riding the near pole horse. The man who rides the harrow not only serves the useful purpose of weighting it down, so that it will cut deep, but he also guides the harrow past the trees by properly adjusting the positions of its two sections. In this way the trees are rarely injured, and yet the harrow can be run very close to them. However, in this particular orchard the use of the harrow is usually preceded by 2 or 3 bouts with a light 1-horse plow along each row of trees.

The homemade leveler shown in figure 8 is also a very useful tillage implement in some orchard districts. Though of special importance in some of the irrigated districts for leveling the irrigation furrows, it is effective in crushing clods and in smoothing the surface of the soil. It consists of two side pieces of 2-inch plank, 12 or 14 feet long

and 6 to 8 inches wide. The crosspieces are 7 or 8 feet wide. The lower edges of the crosspieces where they come in contact with the ground are protected with strips of iron or steel to prevent undue wearing and also to give increased efficiency.

MAINTAINING THE FERTILITY OF THE SOIL.

Good tillage and the maintenance of an ample supply of humus or decaying vegetable matter in the soil will do much to keep it in a sufficiently productive condition for peach growing. But continuous tillage of the soil tends to deplete its content of humus unless it is renewed from time to time.

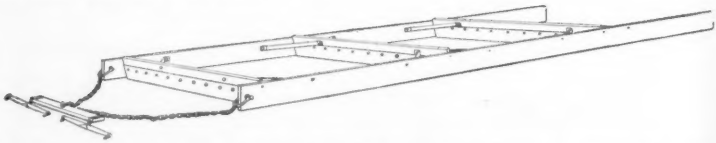

FIG. 8.—A leveler used in some sections for filling irrigation furrows, making the surface of the soil smooth, and pulverizing the clods.

USE OF COVER CROPS.

Where stable or barnyard manure is abundant there is probably no more satisfactory way of supplying humus to the soil than by a liberal use of it. Manure is seldom obtainable, however, in sufficient quantity to meet any far-reaching needs. In its absence the use of cover or green-manure crops is to be advised.

The ways in which a cover crop may contribute to the welfare of the orchard have been enumerated as follows:[1]

(1) It directly improves the physical condition of the land; prevents hard soils from cementing or puddling; holds the rains and snows until they have time to soak away into the land; dries out the soil in spring, making early tillage possible; sometimes serves as a protection from frost.

(2) It catches and holds some of the leaching nitrates, of which the roots of trees are in little need late in the season; adds humus to the soil; renders plant foods available; appropriates nitrogen, if it is a leguminous crop.

The plants commonly used for cover-crop purposes fall into two groups—leguminous (or nitrogen-gathering) and nonleguminous. The former group comprises red clover, crimson clover, bur clover, field peas, vetch, cowpeas, and others: the nonleguminous group consists of rye, oats, buckwheat, millet, rape, turnips, and various others. Sometimes the growth of weeds or other more or less spontaneous growth is encouraged after the seasonal cultivation is ended, as a means of obtaining a cheap supply of vegetable matter for the soil.

Red clover is more commonly used in apple orchards than in peach orchards, and especially when it is intended to omit tillage for a sea-

[1] Bailey, L. H. Op. cit., pp. 184–185.

son. Vetch is apparently being used more and more as an orchard cover crop in the northern fruit districts. Crimson clover is especially satisfactory in some of the light soils in New Jersey and Delaware in seasons when there is a good supply of moisture in the soil at the time of seeding. Cowpeas are very widely used for this purpose in middle and southern latitudes.

Probably rye is the most widely used nonleguminous plant. It can be sowed late in the season, and it lives over winter and starts into growth early the next spring. All of these points are important considerations in many instances. But oats in combination with vetch have been especially satisfactory in some cases, and German millet has been shown to be almost an ideal nonleguminous cover crop under some of the conditions that prevail in Nebraska.[1]

In starting the cover crop, the usual practice is to sow the seed when the orchard is given its last cultivation for the season, usually in July or early in August, though the exact time is regulated by conditions. Sometimes cowpeas are planted in drills in June and tillage continued with a small cultivator. Where rye is used, it is commonly put in toward the close of the growing season.[2]

When a cover crop is used in a peach orchard it should be plowed under as early in the spring as practicable, unless the growth that is on the ground can be worked into the soil effectively and more conveniently by the use of a disk or cutaway harrow. However, if there is an abundance of moisture in the soil, the turning under of the cover crop is delayed in many cases until after it has made considerable growth in the spring, in order to obtain as large a quantity of vegetable matter to be worked into the soil as is possible.

The use of cover crops is sometimes limited in particular seasons by lack of moisture. If there is a protracted drought at the time the seed should be put in and the trees are suffering therefrom, it might do more harm than good to make a further demand upon the moisture in the soil by sowing a cover crop, even though the soil may be known to lack humus.

In certain districts of generally low precipitation in which peaches are being grown successfully, continuous clean tillage, with the return of practically no vegetable matter to the soil, is bringing the ground into poor physical condition. Stable manure as a source of humus is not to be had in sufficient quantity to be of any real value, and the limited moisture supply is not sufficient to maintain the

[1] Emerson, R. A. Cover crops for young orchards. Nebr. Agr. Exp. Sta. Bul. 92, 93 p. 12 fig., 1906.

[2] The amount of seed of the various cover crops commonly sowed per acre is as follows: Red clover, 10 to 15 pounds; crimson clover, 12 to 16 pounds; bur clover, 20 pounds; field peas, 1½ to 2 bushels; vetch, 1 bushel (60 pounds); cowpeas, 1 to 2 bushels; rye, 1½ to 2 bushels; oats, 2 to 2½ bushels; buckwheat, one-half to 1 bushel; millet, 1 to 1½ bushels; rape, 3 pounds; turnips, 3 pounds.

peach trees and grow a cover crop at the same time. This situation as it exists in some districts presents serious problems. The growers are beginning to realize its import.

Likewise in some irrigated districts where the water supply is limited, the need of a cover crop may have to be disregarded, either habitually or in seasons of unusual water shortage, because there is not enough moisture to meet the demands of both the trees and the cover crop.

Aside from maintaining the fertility of the soil, cover crops may have important functions in other respects. Where the soil is subject to washing, a cover crop which survives the winter will often prevent or materially lessen the washing that would otherwise occur.

If good tillage and the wise use of cover crops fail to produce the best results in a peach orchard that is well situated, the use of commercial fertilizers may then logically receive consideration as a last resort.

USE OF FERTILIZERS.

There is no "best" fertilizer for peaches, and no particular fertilizer can be recommended. A fertilizer which is economical to use and which gives maximum results in a particular orchard might be without appreciable effect in another orchard.

In maintaining soils in a highly productive condition it is important to learn what factors are limiting the performance of the orchard. The limiting factor may be an insufficient supply of some kind of plant food, improper physical condition of the soil due to a lack of humus or poor drainage, or it may be something else. The real problem is to determine what the trouble is and then apply the proper remedy, if it is known.

Fertilizers are often largely without appreciable effect if they are applied to soils that are in poor physical condition, as when they are greatly lacking in humus. For this reason attention should be given to the use of fertilizers only after the possibilities of tillage and the maintenance of the soil in good physical condition have been exhausted.

It follows that a complete fertilizer may give excellent results. But if there is an insufficient supply of only one plant food, then it may be assumed that the response from the fertilizer is due to the presence in it of that plant food of which there was an insufficient supply in the soil and that the other plant foods in the fertilizer were without any real value to the crop or trees. Obviously under such conditions a complete fertilizer would not be economical.

The wiser plan is to carry on a few experiments with a view to determining local needs. A representative portion of the orchard may be selected. To a few trees—perhaps 5 or 6—nitrogen may be

applied; to other trees, potash; and to still others, phosphoric acid. Different combinations of these plant foods, including one which has all of them, thus making a complete fertilizer, may be applied to other groups of trees.

If a detailed record is made of the different applications and each group of trees treated the same way each season for several successive years, gradually the results of the different fertilizer treatments will become apparent in the behavior of the trees, their growth and vigor, the productiveness and regularity of the crops, the quality of the fruit, and in other ways. From such results the grower who has carefully studied the conditions should be able to decide upon a rational basis for the use of fertilizers in his own orchard.

IRRIGATION.

Most of the peaches produced in the Intermountain States and west of the Rocky Mountains are grown under irrigation. It is not feasible, however, to discuss the details of irrigation in this bulletin. Attention is called to Farmers' Bulletin 882, entitled "Irrigation of Orchards," which will be forwarded without cost by the Division of Publications, United States Department of Agriculture.

PRUNING.

As a general proposition the most successful fruit growers habitually prune their trees, and in doing it they usually follow more or less closely some plan or system, even though they may have no clear-cut conception of just what their plan involves.

The principal objects sought in pruning may be summarized as follows:

(1) To modify the vigor of the tree.
(2) To keep the tree shapely and within bounds.
(3) To make the tree more stocky.
(4) To open the tree top to admit air and sunshine.
(5) To reduce the struggle for existence in the tree top.
(6) To remove dead or interfering branches.
(7) To renew the vigor of the tree.
(8) To aid in stimulating the development of fruit buds.
(9) To secure good distribution of fruit buds throughout the tree.
(10) To thin the fruit.
(11) To induce uniformity in the ripening of the fruit.
(12) To make thorough spraying possible.
(13) To facilitate the harvesting of the fruit.

The pruning which a tree receives during the first two or three years after it is planted has much to do with its future. Mistakes in forming the head or the results of neglect during the early years in

FIG. 9.—A peach tree of the Muir variety during its first season's growth. The cross lines shown in the figure are intended to suggest suitable points at which to cut the branches when the pruning is done later on. (Photographed in California, Aug. 27, 1913.)

the life of a tree are practically irreparable. On the other hand, if the tree is well formed and properly pruned during its first years, the foundation for a good tree is established; subsequent errors in pruning, if they occur, may admit of correction without permanent harm to the tree.

In general, the proper time to prune peach trees is during the dormant period, preferably in late winter or early spring, just before growth starts, except in regions where bleeding from wounds is likely to occur. In such regions it should probably be done in early winter. But conditions and the object of the pruning must be considered in each case. If the pruning operations are very extensive, it may be necessary to prune throughout the winter whenever the weather is suitable for men to work in the orchard. If the fruit buds are endangered during the winter by adverse temperatures, it may be advisable to delay pruning as much as economic conditions permit until settled spring weather arrives. This is especially advisable if heavy heading back of the previous season's growth is desirable for the sake of the tree, since if a large proportion of the fruit buds are killed it may be best for the prospective crop not to cut back heavily.

A limited amount of summer pruning can usually be done to advantage. The trees should be observed constantly throughout the season of active growth. Whenever a branch is seen to be so placed that it obviously will need to be removed at the annual pruning for the shaping up of the tree, it is well to take it off at once. In this way the annual pruning can be reduced to a minimum and the removal of large limbs will rarely be necessary.

Then, too, it frequently happens that a single branch in the top of a tree will grow considerably faster than any of the others, making the tree unsymmetrical if the growth of the branch is not checked. A slight heading in as soon as such a tendency is apparent will usually keep the top well balanced.

The pruning of a peach tree at the time of planting it has already been discussed. A tree well along in its first season's growth is shown in figure 9. It will be observed that the top is formed of four main branches. This tree shows evidence of having received attention during the earlier part of the season. Only those branches which were of importance in forming the top have been allowed to develop. The exact number of branches which may be used in forming the head is not an arbitrary matter. From three to five branches are permissible, if they are well placed and properly distributed on the main stem of the tree. The branches that form the head of the tree shown in figure 9 start from points on the trunk which are rather too close together. If there was more space between the branches where they join the trunk there would be less danger of the limbs breaking down in later years from the weight of heavy loads of fruit.

During the dormant period between the first and second year, the first year's growth, provided it has been thrifty and vigorous, should be headed back rather heavily; perhaps one-half or two-thirds of the growth should be removed. The cross lines shown in figure 9 suggest suitable points at which to cut the branches when the pruning is done later on. However, this needs to be considered with several things in view: The symmetry of the tree, its strength and vigor, and its future development. In order to provide for an open, well-formed head in later years, it may be necessary to thin out some of the smaller, secondary

FIG. 10.—Peach trees about 3 years old that have not been headed in. The limbs are slender and will probably break badly with the weight of the first good crop of fruit.

FIG. 11.—A peach tree that has been badly pruned. The bearing wood is near the extremities of the limbs. The weight of even a small crop of fruit would be likely to break the limbs to a serious extent.

branches. In doing this, however, provision must be made for a uniform distribution of limbs so spaced that the open top desired will be insured and yet the main limbs still carry an ample number of secondary branches.

Pruning the second and third years does not differ in principle from that which follows the first season's growth. At each pruning the previous season's growth is headed back, though perhaps not quite as much as at the first pruning. This, however, will depend upon the character of the growth and the condition of the tree. If it is stocky and strong, less heavy heading back will be required to serve the end in view, but long, slender, spindling growth should be shortened back as severely after the second or third season as at the earlier pruning.

At each subsequent pruning the secondary branches require the same attention as at the first pruning. The points which require particular attention are thinning out enough to keep the top open and shortening in heavily in order to produce a new growth of bearing wood evenly distributed throughout the top of the tree and on the interior surfaces of the main limbs.

The effects of not heading in are shown in figure 10. The trees here shown are making their second or third season's growth. They were not well headed in at first, and no heading back has been done since they were planted. Besides, the soil is lumpy and in poor tilth, and the trees are making a weak, slender growth. Had they been well headed back, the growth would have been much more stocky, even though the trees were small, and they would be in much better condition to sustain the weight of a crop of fruit than they can possibly be under the system of management that has been followed.

The tree shown in figure 11 has been pruned more or less, but it exhibits serious defects. It has not been well headed back, the top

has not been properly opened, and the smaller, secondary growth has been entirely pruned from a considerable portion of each of the main limbs instead of being utilized to develop fruit-bearing branches in the center, where its weight can best be supported without breaking the tree. With the bearing wood largely developed toward the outer extremities of the branches and the size of the branches disproportionately small for their length, even a small crop of fruit would be likely to break the tree to pieces very badly. This tree may well be contrasted with the trees shown in figures 12 and 13, which have been pruned with a view to developing the characteristics referred to. The limbs are stocky and well proportioned for sustaining heavy crops of fruit. The interior of the trees is well filled with bearing wood and at the same time the tops are sufficiently open to admit a full quota of sunshine to practically all the fruit.

By the time peach trees are 3 or 4 years old they should be bearing good crops of fruit. After this, they will make a smaller annual growth under usual conditions than during the earlier years. Less heading in is therefore required. In some seasons it may not be necessary to cut back the terminal growth, though to do so will tend, as a rule, to develop the smaller secondary and side branches. This is

FIG. 12.—A Levy peach tree 8 years old pruned with a view to developing strong, stocky branches and an open top. (Photographed in California, Aug. 28, 1913.)

FIG. 13.—Phillips peach trees 10 years old. These trees have been systematically headed back, and strong, stocky limbs have developed. It is necessary, however, to prop them when very heavily loaded with fruit. (Photographed in California, Aug. 27, 1913.)

desirable, for reasons already mentioned. Again, the extent of the heading back will be governed in some seasons by the abundance and condition of the fruit buds. If there has been winter injury or if the buds failed to form well the previous season, little or no reduction of the previous season's growth will be needed. On the other hand, if the trees made a strong growth, an abundant set of fruit buds developed, and they have suffered no injury, a correspondingly heavy cutting back of the previous season's growth may be advisable in order to thin the fruit as much as is possible by that means.

Peaches are always borne on wood that grew the previous season. Therefore after a peach tree reaches bearing age it is essential so to manage it as to induce a fairly liberal growth each season.

As a general proposition, very heavy pruning will induce a correspondingly large amount of new wood growth. It follows that the weaker-growing varieties should be pruned more heavily, relatively, than the very strong-growing sorts.

Some of the details of pruning mature peach trees are suggested in figures 14 and 15, which show a tree 8 years old before and after it received the annual pruning to make it shapely, remove superfluous wood, and provide for the development of new growth. While the tree illustrated is far from being ideal, as it had not been well

handled in previous years, it shows certain important features. The heading back of the main limbs will tend to prevent them from becoming "leggy," and it will induce a good, strong growth of new fruit-bearing wood well within the center of the tree. It may require some thinning out at the next annual pruning to prevent the top from becoming too dense. Probably more wood of the previous season's growth should have been left than is shown in figure 15, as there appears to be only a small amount of surface on which fruit can be produced the following season; but apparently the tree has been put in fairly good condition with regard to its later usefulness.

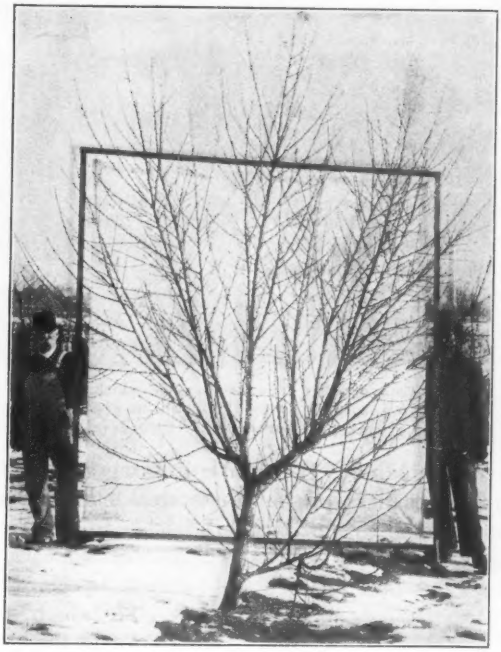

FIG. 14.—A peach tree about 8 years old, before pruning.

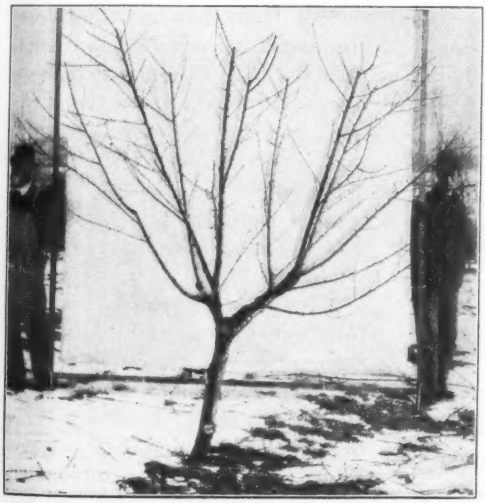

FIG. 15.—The same tree shown in figure 14 after being pruned.

The growing of an open-headed tree is not merely a matter of keeping the top well thinned out. The position of the branches can be controlled and directed to a marked extent by the manner in which the pruning is done. Figure 16 shows two Elberta trees which have a rather remarkable

FIG. 16.—Elberta peach trees 14 years old which have been pruned with a view to producing open, spreading tops. The branches of the two trees together in the foreground have an expanse of about 55 feet. (Photographed in Colorado, Aug. 23, 1910.)

spread of limb. Systematic pruning and heading in were practiced in the earlier years of these trees. The spreading habit has been augmented by cutting the branches to outside buds when they were headed back. The significance of this is more clearly shown in figure 17, which was drawn from life. When the branch was cut back at *b*, during the winter following its growth, the bud nearest the end of the stub was on the outside of the limb. When the branch *b c* developed from that bud the following season, it made a decided angle with the one *a b* on which it developed, thus changing the direction of the growth from that which would have followed the extension of the limb *a b* had it not been cut back and resulting in a considerable widening of the spread of the branches.

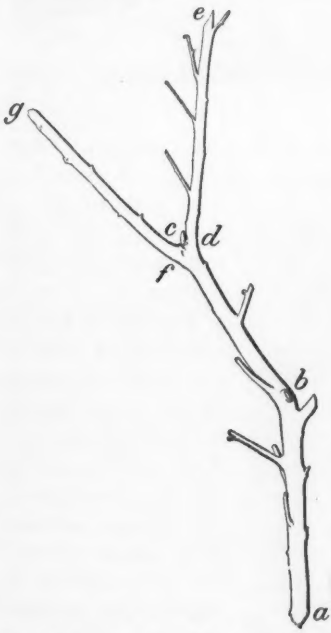

FIG. 17.—A branch which suggests the possibilities of influencing the habit of growth by the position of the bud left at the end when the branch is cut back.

The following season, when the pruning was done and the limb *b c* was cut off at *c*, the outermost bud was nearly on top of the stub at *d*. When this bud gave rise to a branch *d e*, the limb *b c* was continued thereby in approximately the direction of the older limb *a b*.

The limb *f g*, which developed from a bud at *f* which was not as near the end of the stub as was the bud at *d*, did not materially change the direction of the branch *b c*. Had the bud at *d* been on the outside, the spread of the branch would have been still more widened, as was the case when the branch *b c* grew from *b*, the latter being an outside bud. If it is desired to correct the habit of growth in the case of a tree that is too spreading to be desirable, cutting back the limbs to inside buds will tend to accomplish the end in view.

Heading in a tree from year to year as suggested, and pruning with a view to producing an open, spreading, low top results not only in the development of strong, stocky limbs well able to sustain heavy loads of fruit, but it brings a large proportion of the top near the ground, where much of the fruit can be harvested without the use of stepladders.

The man who prunes a fruit tree during its first years must have a pretty clear conception of what the tree is to look like when it reaches maturity, and he needs to know from the beginning what is necessary each time it is pruned in order to develop the tree which forms his mental vision. A well-formed plan, based on a knowledge of the underlying principles of pruning, is essential if the operation is to be anything more than a haphazard removal of branches that appear to be in the way.

FIG. 18.—Pruning Salwey peach trees in an Allegheny Mountain orchard in West Virginia.

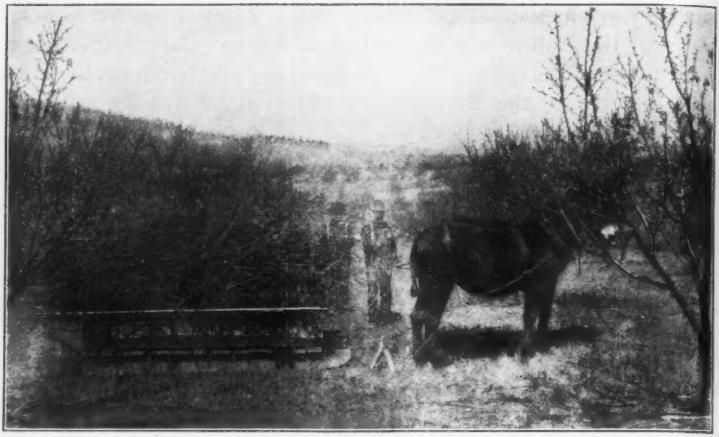

FIG. 19.—A sled used for hauling brush from an orchard. (Photographed in West Virginia.)

Figure 18 shows a type of stool that is used in one of the Allegheny Mountain peach orchards both in pruning the trees and in harvesting the fruit. The legs spread enough to make the stool stand firm and to give the workman a sense of security when standing on it. When intended for use in an orchard that is located on a very steep slope, the two legs on one side of the stool are made somewhat shorter than those on the other side.

A sled similar to the one shown in figure 19 is very convenient under some conditions for removing the brush from an orchard after it has been pruned. Another way of disposing of the brush is shown

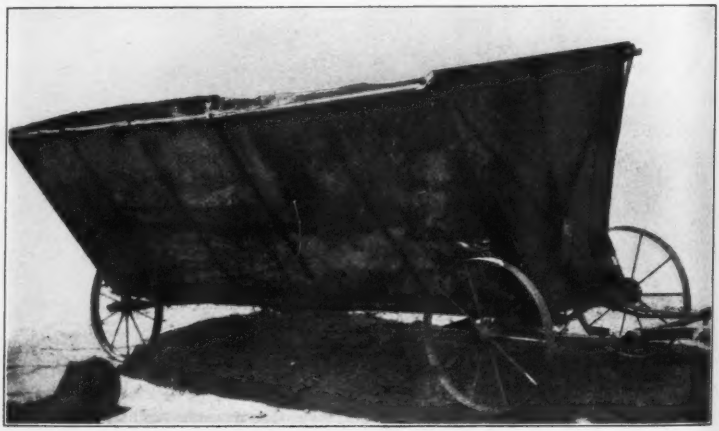

FIG. 20.—A wagonlike device in which the brush pruned from trees is burned as it is drawn through the orchard. (Photographed in California.)

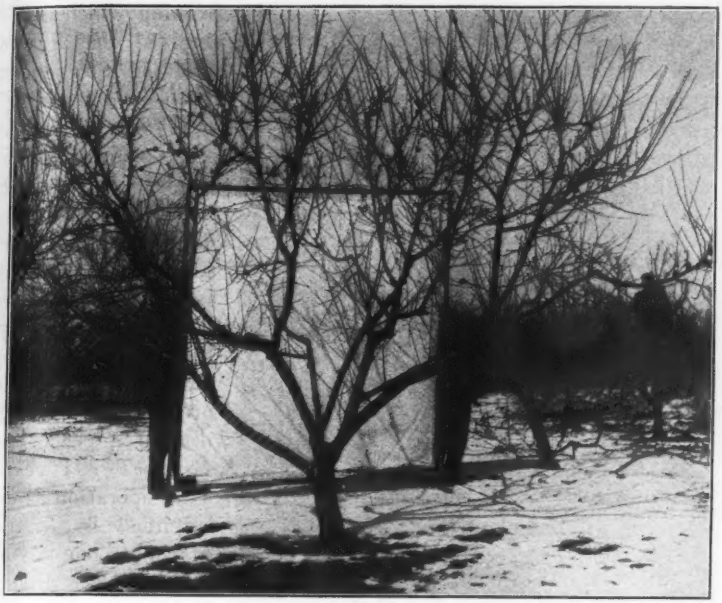

FIG. 21.—A peach tree 8 years old in which the new growth, i. e., the fruit-bearing wood, has been made largely at points far remote from the main limbs.

in figure 20. This device consists of a frame made of piping and lined with sheet iron. It is mounted on iron or steel wheels. The brush is thrown into it and burned as it is drawn through the orchard.

RENEWAL OF THE TOPS.

If a peach tree is neglected as to pruning during its early years and the branches are allowed to become long and slender; if, as it attains considerable age, the bearing wood, in spite of the

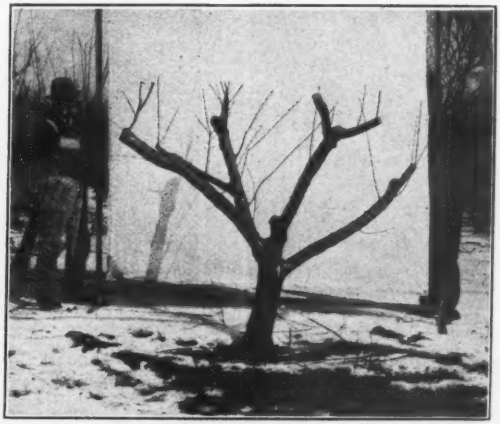

FIG. 22.—The tree shown in figure 21 after being deheaded.

FIG. 23.—The tree shown in figures 21 and 22 during its second season's growth after being deheaded.

pruning which it has received, has grown out of convenient reach in harvesting; or, if for other reasons it becomes desirable to renew the top of a tree, it is usually entirely practicable to do so, provided the trunk and main limbs are sound and healthy. Renewal of the top will often result in prolonging the usefulness of a peach tree for several years. This operation is exemplified by several of the accompanying illustrations. Figure 21 shows an 8-year-old peach tree which has become rather "leggy." The annual growth for several seasons has nearly all been made near the extremities of the limbs. Very little new wood has grown in the interior of the tree.

Figure 22 shows the same tree after being severely headed in, or "deheaded," with a view to developing a new top. The small branches which remain on the stubs of the old limbs are an advantage, as they will start into growth more readily than the latent buds from which the new top would have to develop in the absence of small branches of recent growth.

Figure 23 is a third view of the tree shown in figures 21 and 22, well advanced in its second season's growth after being deheaded. This particular tree was somewhat lacking in vigor, and its growth following the treatment for the renewal of the top was not as satisfactory as it otherwise would have been. Figure 24 shows a 7-year-old Elberta tree which was thrifty when it was headed back to about the extent indicated in figure 22. The illustration shows this tree near the end of its first season's growth after being deheaded. It should bear a crop of fruit the next season.

If a tree which lacks vigor is treated in this way, the results shown in figure 25 may occur. Some of the stubs had no buds strong

enough to develop; hence, the top was only partially renewed. If the tops are cut back to wood that is not more than 3 or 4 years old, a stronger, more symmetrical growth may be expected than where the stubs left in deheading are older. Occasionally, where the trunk remains sound and retains its vigor, the tops are renewed two or three times. As a rule, however, it is impracticable to dehead for renewal more than once.

Sometimes, when for any reason it is desirable to renew the top of a comparatively young tree, the heading in may be made much more severe than that suggested by figures 22 and 25. This is shown in figure 26, where all the branches have been cut back to the trunk of the tree.

The season for deheading to renew the top is the same as that for doing the annual pruning for the shaping of the trees and the removal of superfluous wood—that is, during the dormant period.

When the vigor of peach trees has been well maintained by good cultural methods, suitable pruning, and wise management in every respect, their life of commercial usefulness is generally from about 8 to nearly 20 years after the full-bearing age is reached. It varies widely, however, under different conditions. In some sections, it is rarely profitable to continue them after they reach the age of 12 to 15

FIG. 24.—An Elberta peach tree 7 years old that was deheaded about as indicated in figure 22, showing its first season's growth after being cut back. It should bear a crop of fruit the following season. (Photographed Aug. 15, 1911.)

FIG. 25.—A peach tree that has been deheaded, but which did not develop a symmetrical top because some of the stubs had no buds strong enough to develop branches.

years; in others they are expected to last until they are from 15 to 18 or 20 years old, while occasionally an orchard 20 to 25 years old is found which is still of commercial value. Instances of individual trees remaining productive until a much greater age are not uncommon, but they seldom, if ever, represent orchard conditions.

CHANGING THE TOP BY BUDDING AND GRAFTING.

Sometimes it is desirable to change the top of a peach tree from one variety to another. A grower may find after his orchard begins to bear that he has a larger number of trees of some variety than he wants; a block of trees may prove to be some other variety than the one ordered; or, for some other reasons, a variety is not well adapted to the needs of the owner. In such cases he may top-work the tree either by budding or by grafting it to a desirable variety.[1]

The ordinary method of shield budding is most commonly used for this purpose. If the tree to be top-worked is not more than two or three years old it is usually practicable to insert the buds directly into the main limbs well down toward the point where they leave the trunk. This is illustrated in figure 27, which shows a Triumph peach tree that was budded to the Carman variety when it was 3 years old, after its crop of fruit had been removed. The points where the buds were inserted are shown in the figure.

If the tree to be top-budded has reached the age when the bark on the main limbs has become too thick and firm to be manipulated

[1] The operations of budding and grafting are fully described in Farmers' Bulletin 157, entitled "The Propagation of Plants," which will be forwarded without cost on application to the Secretary of Agriculture.

readily for budding, it is necessary first to head it back somewhat, as when the top is to be replaced with new growth of the same variety, and later insert the buds on the new branches that develop after the tree has been deheaded. When this course is followed, the buds should be inserted in the new growth as near the trunk as is practicable, in order to have as large a portion of the top as possible of the new variety. This is also desirable on account of the subsequent management of the tree.

Top-working is sometimes done by grafting instead of budding, the ordinary cleft graft being generally used. However, budding is to be preferred, especially as the wounds made in grafting do not heal readily in the case of the peach, though when properly done the union of stock and scion is generally strong enough to make a fairly serviceable tree. But troubles resulting from difficulties in the healing of the wounds are likely to occur.

THINNING THE FRUIT.

Most varieties of peaches, as well as other fruits, for that matter, under favorable conditions often set much more fruit than the tree can possibly develop to a good degree of perfection for commercial purposes. The natural tendency of the tree is to perpetuate its kind. To this end, left to itself, it develops the largest possible number of seeds, with each seed possessing the possibility of a new tree.

The grower's aim, however, is for the tree to produce the largest possible amount of fruit that can attain the highest commercial standard. The effort of the tree and the object desired by the grower tend to impose incompatible requirements. The development of a great number of

FIG. 26.—A peach tree that shows the possibility of developing an entirely new top when the limbs are cut back to the trunk. This is not likely to be successful except on comparatively young trees.

FIG. 27.—A 3-year-old Triumph peach tree top-budded with the Carman variety after harvesting the season's crop of fruit. This shows the tree about one year after the Carman buds were inserted at *a*, *b*, *c*, and *d*.

seeds is a tree-exhausting process. This is opposed to the development of large fruits. To meet his ends in this respect, the grower has recourse to thinning the fruit.

Perhaps no operation in the production of peaches requires keener judgment than thinning the fruit. No fixed rules for it can be given. A common practice, very generally applicable, is to thin so that the fruits will not be nearer together than 4 to 6 inches. But the strength of the tree, the fertility of the soil, and especially the soil moisture, together with the size of the crop (or, in other words, the number of fruits allowed to develop on the tree), govern very largely the size and perfection of the individual fruits.

Obviously, a vigorous tree growing under favorable conditions as to moisture, plant food, etc., can develop a larger number of fruits to good size than can a weak tree, or even the same tree when there is a marked deficiency either in the supply of moisture or of plant food.

The skill of the grower is shown in his ability to adjust the size of the crop on his trees to the conditions of the season. He can reduce the number of fruits on the trees if the season becomes very dry as it progresses. Thus the grower should aim to control the size of the individual fruits by thinning and by tillage and pruning.

While thinning may cost a relatively large amount per tree, actually more high-grade fruit is produced, as a rule, on a tree which bears only a moderate crop than on one which is heavily overloaded, and the average fruit on the tree with a moderate crop is of better grade than the best fruit on an overloaded tree.

The thinning should be done after the "June drop"—which usually occurs from a month to six weeks after the blossoming period, when the imperfectly fertilized and other weakly developed fruits drop off—and before the pits begin to harden. After the "June drop" is over there is very little dropping of the peaches. Hence,

practically all the fruit which remains then will be on the trees at harvest time. It will have to be picked then, anyway. It probably costs considerably less to pick a portion of the crop in June or July and drop the fruit on the ground than to pick it later and put it in a basket, where much of it will have to be handled over several times in grading and packing and then finally large quantities discarded as culls because the fruits are so small. Moreover, the fruit on an overloaded tree will sometimes ripen less uniformly than on a tree that has a moderate crop.

As the development of its pits is an exhaustive process, the limiting of the number of fruits tends to conserve the vitality of the tree. A large portion of the flesh of the peach is water; hence, if the soil is well supplied with moisture the development of the edible portion of the fruit makes a relatively light demand on the strength of the tree.

CONTROL OF INSECT PESTS AND FUNGOUS DISEASES.

After a grower has pruned intelligently, tilled and fertilized his orchard well, and irrigated it if required, the orchard may be short lived and the crops financial failures if he neglects to give proper attention to the control of insects and diseases, a considerable number of which are to be found pretty nearly everywhere in the sections where peaches are grown.

Emergency matters should be referred to the agricultural experiment station of the grower's State without delay.

Inquiries relating to any phase of fruit growing may also be referred at any time to the United States Department of Agriculture, where, without cost, through the department's experts, as full information relative to the problems as can be given may be obtained.[1]

GROWING CROPS BETWEEN THE TREES.

Frequently some annual crop is grown between the trees during the first two or three seasons to help meet the cost of maintenance during the unproductive age of the orchard. This practice is seldom any advantage to the trees in comparison with thorough tillage by itself, but if the crops are wisely selected and properly managed they are not likely to do any serious harm.

The crop ought to be one which needs essentially the same tillage that the peach tree should have, so as not to interfere seriously with that operation. But the grower should realize that he is, in effect, following a system of double cropping and that because of the crop between the trees he may need to give more attention to maintaining the fertility of the soil than he would for the peaches alone.

[1] Farmers' Bulletin 932, entitled "Spraying Peaches for the Control of Brown-Rot, Scab, and Curculio," obtainable from the Department of Agriculture on request, is of value to peach growers who have these troubles to combat.

After the trees reach bearing age they should not be made to compete with another crop. Even if the plant food in the soil is sufficient to produce successfully two crops at the same time, the peach trees usually will need all the available soil moisture, except, of course, in sections where irrigation is practiced and the supply of water is adequate for all purposes. Besides, a crop between the trees would be likely to interfere with the spraying of the trees (if the operation should be necessary), with the harvesting of the fruit, and in other ways.

Muskmelons, beans, peas, cabbages, tomatoes, and other truck crops are extensively grown between peach trees in different sections. Potatoes are sometimes used, but they are suitable only when the crop can be so managed that the digging of the potatoes will not amount to a late cultivation, which may be attended with undesirable results. Corn, also, is frequently used, but as very often managed it is objectionable, because it shades the trees excessively. Whenever corn is used, an open strip of considerable width should be left along the rows, so that the trees will be fully exposed to the sunlight throughout the season. If a very tall, strong-growing variety of corn is used, a wider strip should be left unplanted than where a dwarf variety is selected.

Peach trees are sometimes used for planting between trees, especially where apples comprise the permanent crop. This practice is highly recommended by some and emphatically condemned by other fruit growers of wide experience. It is probably objectionable in that for a period of years both bearing and nonbearing trees occupy the same area, and it is sometimes desirable to treat a fruiting tree very differently from one that is not fruiting, for the best results with each. On the other hand, where a site is particularly favorable for both fruits, a compromise treatment can often be effected which yields fairly satisfactory results with both kinds of trees.

ORCHARD MANAGEMENT AND WINTER INJURY.

In nearly all of the experiment-station bulletins on peach culture, in current horticultural literature, and in the standard works in which peach growing is discussed in detail, emphasis is habitually placed upon the necessity of so managing the orchard that the trees will cease growing and the wood become fully mature before the advent of cold weather. Otherwise, serious winter injury is anticipated. To accomplish this end it is generally advised to cease tillage in July or early August, to withhold fertilizers rich in nitrogen, and to avoid excessively fertile soil in selecting sites for peach orchards.

Undoubtedly such advice is perfectly sound and applicable to a large proportion of the peach-growing districts, but there appear to

be some rather marked exceptions that are applicable in important peach-growing sections, to which the reader's attention may well be directed.

These exceptions to the general practice have been brought to light largely through investigations carried on by the Missouri Agricultural Experiment Station.[1] They consist primarily in so managing the orchard as to maintain the trees in active growth until rather late in the season. This may be accomplished by continuing the tillage later than is ordinarily advised, by using a nitrogenous fertilizer, or by heavy pruning, which results in a vigorous growth of new wood. Any condition that seriously reduces the vitality of the tree tends to make the tree, especially the fruit buds, susceptible to injury by winter temperatures. The production of an excessive crop of fruit is a common cause of depleted vitality. The conclusions of the Missouri experiment station tentatively summarized are as follows:[2]

Where nitrogen was applied to peach trees a good crop was produced and harvested. On plats receiving no fertilizer there was practically no crop. There was likewise a failure of peaches in the surrounding region where no fertilizer was applied. The cold winter of 1911–12 was disastrous to peach trees in Missouri. Injury to peach trees caused by the cold so weakened their vitality that disease like the bacterial shot-hole leaf disease was common. On the plats fertilized with nitrogen there was little bacterial disease. On adjacent unfertilized plats the injury from this cause was very great. The trees in the plats fertilized with nitrogen also recovered from winter injury much more successfully and quickly than unfertilized trees in the same locality.

The application of phosphorus and potassium either singly or in combination did not result in increased yields. The results of the investigations on fertilizers for peaches seem to indicate clearly that a nitrogenous fertilizer or a method of cultivation and management which favors a vigorous tree growth when combined with pruning, spraying, and thinning fruit on overloaded trees will increase the crop. The above treatment tends to make them carry their fruit buds through winter and frosts of spring much more safely than where an average or weak growth only is secured. Our results seem to disprove the theory that trees must make their main growth early in the season and then be checked or retarded in their growth in August or September in order to ripen their wood before going into winter. In some experiments at this station where the trees have been encouraged to grow vigorously right up until some of the green leaves froze on the trees, either by the use of fertilizer or by severely pruning back the winter before or by thinning the fruit, they have uniformly carried their fruit buds through the winter much more safely than with trees that shed their leaves and ripened their wood early.

[1] Missouri Agricultural Experiment Station Bulletin 74, entitled "The Winter-Killing of Peach Buds as Influenced by Previous Treatment."

Missouri Agricultural Experiment Station Circular of Information 31, entitled "Hardiness of Peach Buds, Blossoms, and Young Fruit as Influenced by the Care of the Orchard," being a reprint from the Annual Report of the Missouri State Board of Horticulture, 1908.

Missouri Agricultural Experiment Station Bulletin 111, Report of the Director for the Year Ending June 30, 1912.

[2] Missouri Agricultural Experiment Station Bulletin 111, Report of the Director for the Year Ending June 30, 1912, pp. 247–248.

A very careful correlation of these results with the conditions which are generally considered essential in the growth of peach trees in the northern districts is necessary in order to understand their significance. There is no real conflict or lack of harmony in the methods advised for the different regions, though in the abstract they may appear to be directly incompatible.

On the other hand, they illustrate very forcefully the fact that the blind application of definitely stated rules is likely to work disaster. The importance of intelligently adapting the methods used to the conditions which have to be met in different fruit-growing regions is emphasized.

The differences in the conditions in the northern peach districts and in those met in connection with the investigations of the Missouri experiment station are largely differences in the climate during the winter season.

In the northern districts the normal winter is continuously cold and without any warm spells of sufficient duration to affect the dormancy of the trees. It usually remains cold until winter finally breaks. When it warms up enough to start the trees into activity and cause the buds to swell, there is comparatively little danger thereafter of serious frosts or freezes. Moreover, the critical factor—the one which largely governs the management of the orchard in the present connection—is low winter temperatures which are sufficient to kill the buds or injure the trees even when they are perfectly dormant. To best meet this low-temperature factor, it is recognized that the trees must be thoroughly dormant and the current season's growth well ripened.

In regions where the Missouri methods are applicable, critically low winter temperatures are of little concern, provided the trees are in a dormant state. But the winters are characterized by warm spells in December, January, and perhaps in February, which are sufficient to start the buds. This makes them tender and susceptible to injury later in the season by temperatures that are entirely seasonable and which would be of no concern to the peach grower if the buds were dormant. The trees often blossom early and before the season of spring frosts is past.

The reason for continuing the growth of the trees until late in the season in these regions is based on the fact, the practical importance of which is shown in the investigations referred to, that the rest period, or period during which the trees normally remain dormant, is one which by nature continues for a fairly definite period of time. Until that period is past, when once they have become dormant, the trees do not respond readily to temperatures which later would cause them to resume a more or less active condition and might result in the buds swelling enough to make them tender.

This is a matter that is relatively unimportant in regions where the entire winter season is normally characterized by temperatures which are not sufficiently high to affect vegetation, but it has a very important significance in the regions in which warm periods of considerable length occur during the winter. If all the agencies which tend to stimulate the growth of the trees are discontinued relatively early in the season, the trees will cease growing and begin to ripen their wood at a correspondingly early date; the resting period inherently required by the trees is then completed early in the winter. If a spell of warm weather occurs soon after that period is ended, as, for instance, in January, the trees will respond to it; the buds will begin to swell and soon become tender. On the other hand, if the growth of the trees is continued actively by means of late tillage, nitrogenous fertilizers, or in other ways, until the near approach of cold weather, the period of rest and dormancy inherently required by the trees is not completed until a correspondingly later time in the winter. Under these conditions the trees remain inactive during warm spells in December or January, and the buds do not swell enough to become tender until many of the dangers incident to adverse winter temperatures are past.

While the application of these methods, which have in view the results that follow the continuation of active tree growth until late in the season, may be somewhat restricted, they are undoubtedly worthy of the most careful consideration by peach growers who are located in regions where the winters are characterized by warm periods of sufficient length to cause the trees to become more or less active before settled spring conditions arrive.

There are a few special methods and practices in the management of peach orchards which are of sufficient importance in some sections to justify brief reference to them here.

The Ohio Agricultural Experiment Station has called attention to the efficacy of slightly mounding up the soil about the base of the trees in preventing injury during periods of excessively low winter temperatures. In the same connection it has been shown that various other factors relating to the soil may greatly influence the amount of damage which peach trees suffer during such periods.

The winter of 1903–4 was characterized in the Lake Erie peach district of Ohio by periods of severe and prolonged cold. Great numbers of peach trees were killed. The prevailing conditions and their attendant results on the peach trees are summarized as follows:[1]

Exceptional causes of susceptibility to cold in rare cases of apparently healthy, vigorous trees: Low, moist, rich black soil which favored an extreme growth of soft, poorly ripened, or matured wood; or high culture upon soil rich in plant food which brought about similar results.

[1] Ohio Agricultural Experiment Station Bulletin 157, "Winter-Killing of Peach Trees," p. 132.

The unusually deep, hard freezing of the earth's crust was due, directly, to the continued, steady cold, but was intensified, in many instances, by a lack of humus or vegetable matter in the soil, which constitutes nature's insulation of the surface of the earth from cold and heat.

Providing that the orchards had been kept free from fungous disease and the San Jose scale by timely and thorough spraying, no injury of trees was found where stable or barnyard manure had been used upon the ground within the last year or two previous to the winter of 1903–4; rarely was an injured tree found standing in sod; no injury was done where the surface of the soil beneath the trees had been covered with even a very slight mulch; little injury was done where the trees stood in fairly well-drained soil containing a moderate amount of fertility and humus; no injury was found where the trees were under the grass-mulch method of culture . . .; no injury was observed in any case where the stems of the trees had been slightly banked or mounded with a few shovelfuls or forkfuls of soil, peat, or manure.

Very few trees which, within the past few years, had been affected with leaf-curl or infested with San Jose scale or borers remained alive or uninjured; and very few trees existing upon infertile or exhausted soil, depleted of humus, escaped uninjured.

The usefulness of a cover crop in preventing the washing of the soil during the dormant period of the trees is frequently well demonstrated. Moreover, in some regions where the winters are rather severe and there is a very limited snowfall, a cover crop prevents the snow from blowing away, thus affording additional protection against the extreme freezing of the roots.

Another practice which is entirely regional, but which may be of considerable advantage at times, is the shading of the trunks of the trees with board protectors, lath screens, or in some other equally effective manner. This method is of use particularly in regions in which long periods of extremely hot weather usually occur and where the trees are not well shaded on the south and southwest sides. Shading in the manner suggested sometimes affords a measure of protection against the form of winter injury commonly called "sun scald." This is generally caused by too rapid thawing after the trunks have been frozen very hard.

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GROWING PEACHES

SITES AND CULTURAL METHODS

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U. S. Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE

IN ITS commercial and economic importance in this country the peach is second only to the apple among deciduous-tree fruits. Commercial peach interests exist in about three-fourths of the States, with some home plantings in most of the others.

The peach grower who has had only limited experience will find in this bulletin information concerning some vital factors which largely determine the success of a peach orchard.

Emphasis is placed upon suitable location and site, because a faulty choice of either may be fatal to future financial success. Some mistakes in planning an orchard can be overcome as the orchard develops, but a poor location or site is beyond remedy.

The basic operations of planting, tillage, maintaining soil fertility, and pruning are discussed in this bulletin.

Spraying for certain insects and diseases of the fruit is discussed in Department Circular 216; information about insecticides, spraying apparatus, and insect pests of the peach and other fruits will be found in Farmers' Bulletin 908; the choice of varieties for planting in different regions is considered in Farmers' Bulletin 918; the peach borer and methods of control are treated in Farmers' Bulletin 1246 and in Department Bulletin 1169; and the preparation of peaches for market in Farmers' Bulletin 1266. These bulletins can be secured free of cost on application to the Office of Information, United States Department of Agriculture.

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GROWING PEACHES: SITES AND CULTURAL METHODS

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DISTRIBUTION AND STATISTICS OF PEACH GROWING

PERHAPS there is no better way of showing the trend of the peach industry during the past 30 years so far as the distribution of orchards is concerned and its present extent than by means of the census figures, which are shown in Table 1. One of the interesting deductions to be made from the figures is the widespread cultivation of the peach. In more than 30 of the 48 States there are peach interests of commercial importance. The limiting factor in the States where few trees are grown is doubtless extremely low winter temperatures. Yet in the milder portions of even these States, especially in protected localities, the growing of peaches is not an impossibility. It is obvious, however, that where the limit of possibility is approached, the number of crop failures may be expected to be large in comparison with the number of good crops.

Wide differences appear in the number of bearing trees in certain States in the different 10-year periods, some of which indicate a very large increase, while others show a large decrease in the peach industry. In some of the important peach-producing States in 1910 there were also nearly as many trees—in several instances considerably more—not of bearing age as of bearing age. This was not the case, however, in 1920, the number of trees not of bearing age being relatively less than in 1910.

LOCATION AND SITE

The location of an orchard has to do with its general surroundings. It may relate to transportation facilities, markets, climatic conditions, and the geographical position of the district or region in which an orchard is placed, or, in other words, its local geography. The site has to do with the particular piece of land occupied by the trees. It relates to the soil, slope, atmospheric drainage, and other natural factors which affect the suitability of a given area of land for peach growing.

A location may have every natural advantage as to climate, soil, and other local conditions for the successful growing of peaches and yet, because of its remoteness from a shipping station, distance from suitable markets, or even the impracticability of supplying ice for refrigerator cars, it may be impossible to market them profitably. Moreover, a location may have all these advantages to a satisfactory degree and yet not be desirable for commercial peach growing, because the markets within its logical radius for distribution are already abundantly supplied with peaches from districts which in some important respects are more advantageously placed.

TABLE 1.—*Distribution of peach trees*[1] *by States, as shown by census reports*

States	Number of trees of bearing age—				Trees not of bearing age—	
	Eleventh Census, 1890	Twelfth Census, 1900	Thirteenth Census, 1910	Fourteenth Census, 1920	Thirteenth Census, 1910	Fourteenth Census, 1920
New England:						
Maine	1,607	9,592	5,102	5,666	3,320	2,570
New Hampshire	19,057	48,819	57,571	81,287	35,213	23,200
Vermont	1,966	4,993	5,492	2,915	2,187	3,978
Massachusetts	87,004	301,405	154,592	346,260	162,114	135,426
Rhode Island	11,816	48,063	39,342	61,125	30,795	25,366
Connecticut	88,655	522,726	461,711	495,750	338,608	133,577
Middle Atlantic:						
New York	1,014,110	2,522,729	2,457,187	3,038,023	2,216,907	658,868
New Jersey	4,413,568	2,746,607	1,216,476	1,936,632	1,363,632	884,067
Pennsylvania	1,146,342	3,521,930	2,383,027	3,563,726	2,179,386	1,234,708
East North-Central:						
Ohio	1,882,191	6,363,127	3,133,368	2,924,177	2,092,300	970,183
Indiana	953,980	2,925,526	2,130,298	860,024	1,145,479	568,046
Illinois	783,910	2,448,013	2,860,120	1,011,325	739,358	839,712
Michigan	1,919,104	8,104,415	2,907,170	2,010,022	2,991,090	764,838
Wisconsin	387	6,967	4,163	1,522	4,148	1,153
West North-Central:						
Minnesota	334	1,626	1,571	890	3,837	427
Iowa	82,238	516,145	1,090,749	129,939	283,308	61,043
Missouri	1,999,474	4,557,365	6,588,034	2,358,925	1,404,429	716,325
North Dakota		2	90	38	604	32
South Dakota	78	1,080	1,815	109	5,259	177
Nebraska	144,701	1,055,959	1,188,373	95,629	263,882	40,118
Kansas	4,876,311	5,098,064	4,394,894	844,498	620,709	278,914
South Atlantic:						
Delaware	4,521,623	2,441,650	1,177,402	464,514	212,117	93,336
Maryland	6,113,287	4,017,854	1,497,724	997,086	805,063	285,486
District of Columbia	1,521	149	330	1,208	1	236
Virginia	1,218,219	1,939,113	1,585,505	1,578,253	780,551	783,733
West Virginia	450,440	1,695,642	1,424,582	2,049,862	1,441,188	651,742
North Carolina	2,133,004	2,773,788	2,661,791	1,976,756	861,042	1,093,993
South Carolina	711,138	1,136,790	1,336,142	871,976	349,790	335,599
Georgia	2,787,546	7,668,639	10,609,119	8,655,051	1,531,367	3,391,851
Florida	235,936	354,208	290,850	206,155	156,782	116,913
East South-Central:						
Kentucky	1,205,866	2,884,193	2,245,402	1,671,044	1,110,744	690,483
Tennessee	2,347,699	2,749,203	3,163,737	2,349,656	1,190,727	690,359
Alabama	1,280,842	2,690,151	3,177,331	1,544,700	838,866	546,024
Mississippi	878,569	1,856,748	1,726,298	855,158	724,895	493,651
West South-Central:						
Arkansas	2,769,052	4,062,218	6,859,962	3,342,387	2,884,927	988,966
Louisiana	317,132	758,877	903,352	408,178	316,132	231,909
Oklahoma	206	2 5,848,808	4,783,825	2,879,945	2,574,680	637,762
Texas	4,486,901	7,248,358	9,737,827	4,461,717	2,958,813	1,640,848
Mountain:						
Montana		1,670	538	1,831	3,386	430
Idaho	13,639	79,757	73,080	178,434	212,995	26,648
Wyoming		9	46	19	419	33
Colorado	8,204	319,998	793,372	446,943	606,001	32,158
New Mexico	23,081	117,003	136,191	154,968	184,466	36,923
Arizona	24,954	67,073	51,415	101,855	32,562	26,681
Utah	68,121	409,665	544,314	554,202	651,233	28,531
Nevada	3,996	9,136	6,329	5,940	5,049	3,721
Pacific:						
Washington	72,701	226,636	536,875	649,085	1,028,141	50,254
Oregon	115,244	281,716	273,162	412,936	508,179	20,911
California	2,669,843	7,472,393	7,829,011	9,057,760	4,409,562	1,366,941
Total	53,885,597	99,916,598	94,506,657	65,646,101	42,266,243	21,617,862

[1] Includes also nectarines, but the number of nectarine trees is so small as to be practically negligible.
[2] Includes Indian Territory.

It is likewise true that within a district which as a whole is well located for commercial peach growing there may be and usually are sites which are not adapted to this purpose, for reasons that are entirely local. This is especially apt to be the case in mountainous districts or wherever the topography is much broken and soil conditions are very variable. Especially careful discrimination in the selection of sites for orchards is essential in such districts. Figures 1 and 2 show typical orchard sites in im-

portant peach-growing districts in mountainous sections in widely separated parts of the country.

SITES WITH REFERENCE TO SOIL

It is the current opinion that the peach should be planted on sandy or some of the lighter types of soil. Excellent results may follow the planting of orchards on such soils, but peaches do well also on a wide range of soil types, including even some of the moderately heavy clay loams and clays. But whatever the type, a soil must be thoroughly well drained. Peaches will not succeed on poorly drained soils. The heavy clay types which are so hard and impervious that water does not percolate through them readily are to be avoided. Moreover, the soil should be moderately fertile. One very rich in nitrogen is not desirable as a general rule, since it may induce an excessive growth of foliage, but the impression that a poor, infertile soil is "good enough for peaches" is erroneous.

Where alkali soils occur, they should be avoided. While the peach tree can be grown where there is a limited amount of the alkali salts, they cause disaster if present in large quantities. It is safer, therefore, to avoid them as far as possible.

SITES WITH REFERENCE TO ELEVATION

Generally a site that is elevated considerably above the surrounding areas is to be preferred for a peach orchard. Cold air settles to the lower levels. For this reason it is often colder at the lower elevations than it is at high points. This is what is meant by "atmospheric drainage." The occurrence of frost in low places when there is none on elevated areas is thus explained. For the same reason peach buds are often winterkilled or the blossoms are injured by frost in the spring in low places when nearby orchards on higher elevations are injured much less, or even escape entirely. During the past few years the importance of selecting relatively high sites for peach orchards in order to avoid the effects of unfavorable temperatures has been emphatically demonstrated in many different parts of the country. There are, however, certain general exceptions to the foregoing statement. Where an orchard that is well elevated above the surrounding country is exposed to low temperatures which are accompanied by severe winds, the fruit buds are sometimes injured, when in the orchards at lower levels in the same locality, where there is protection from the wind, no injury occurs. However, injury under these conditions is rather rare in comparison with that which occurs in orchards that occupy relatively low sites.

FIG. 1.—A fairly typical peach-orchard site in the Allegheny Mountain district of West Virginia, this being in Morgan County. In many instances the soil and other conditions in the valleys between the ridges are not well suited for peaches, even though the ridges may be admirably adapted to them

SITES WITH REFERENCE TO BODIES OF WATER

When an orchard has a site adjacent to a body of water of sufficient size and depth to have an appreciable influence on the local climate, the importance of a relatively high elevation

largely disappears. Because water warms up in the spring more slowly than the atmosphere it acts, in effect, as a refrigerator, making the temperature in its immediate vicinity colder than at points somewhat distant from it. Vegetation within the zone of this influence advances more slowly in the spring than it does outside of that zone. The tendency is for the blossoming of peach trees within the zone to be delayed until after the season of spring frosts is past.

In the fall frosts are delayed. The water, having absorbed much heat during the summer, cools off in the fall more slowly than the atmosphere and tends to keep the temperature within its zone of influence warmer than it would otherwise be.

For these reasons peaches are grown with marked success in the portions of

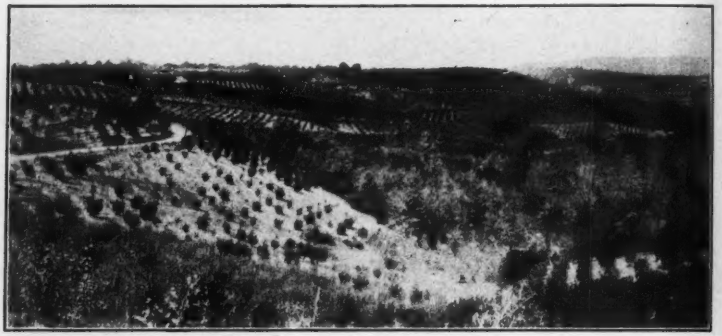

FIG. 2.—A fairly typical peach-growing section in a foothill district in California, this being in Placer County. Though the surface is much broken, these orchards are all irrigated

New York and the Province of Ontario that border Lake Ontario, in Ohio along Lake Erie, in southwestern Michigan on Lake Michigan, and in some other districts adjacent to large bodies of water. The influence of such bodies of water usually does not extend back from the shore more than a few miles, though the slope of the land with relation to the water determines largely the extent of the area affected.

SITES WITH REFERENCE TO SLOPE

The slope or exposure of a site has reference to the point of the compass toward which the land inclines. No one slope is preferable under all conditions and in all regions. A site having a moderate slope in some direction probably is to be preferred for orchard purposes to one that is level, as one with a slope will usually have better soil and atmospheric drainage than a level area; but one slope may be as good as another.

An orchard that occupies a site which slopes away from the prevailing wind may be afforded a certain amount of protection therefrom, and in some regions there are well-marked soil differences on the different slopes of the ridges. These differences may be such as to make one slope better adapted to peach growing than another.

The slope factor, however, is largely one of degree. Peach trees on a site having a very steep southern slope will usually blossom and the fruit will ripen somewhat earlier than on a corresponding northern slope, but where the differences in slope are only moderate their relative influence on the time of blossoming and ripening is not very marked. Whether early or late blossoming is desirable is largely a local matter and depends primarily on the relative dates of blossoming and the usual occurrence of spring frosts in any locality or on any site.

TEMPERATURE A LIMITING FACTOR

Aside from economic factors, temperature probably is the most decisive limiting factor in the distribution of commercial peach growing. Usually the fruit buds are the first to suffer injury. No absolute minimum temperature which the peach is able to withstand without injury can be given. The condition of the buds with regard to their strength, vitality, and perfect dormancy, the duration of the critical

temperature, the climatic conditions following the cold period, perhaps the amount of moisture in the air during the period, and other factors—all have an influence.

In many peach districts, however, the growers are always apprehensive of injury, even with buds in good condition and all other factors favorable, whenever the temperature reaches 10° to 20° F. below zero, though buds of many varieties often withstand temperatures considerably lower than this when all other conditions are favorable.

Where severe spring frosts occur from year to year during the blossoming period it is not practicable to produce peaches on a commercial basis. Similarly, regions in which protracted warm periods occur from time to time during the winter have usually proved to be uncertain for peaches. The trees become more or less active during the warm periods; the buds start enough to become tender and are injured later even by temperatures which may not be unseasonable for the latitude. For this reason winter and spring injury is sometimes experienced in middle and southern latitudes when peaches in the northern districts escape.

Orchard heaters offer a measure of relief under some conditions in districts subject to unseasonable spring frosts, but such districts are, nevertheless, seriously handicapped in comparison with those where disastrous frosts rarely occur.

PROPAGATION OF PEACH TREES

The average peach grower is not concerned directly with the propagation of trees. It is generally more advantageous for him to purchase them from one who makes the growing of trees his special business than to grow them himself. However, the general features of propagation should be understood by those engaged in peach growing. They are, therefore, briefly outlined in the present connection.

The site selected for a peach nursery should be one that is well drained and where the soil is preferably rather light, though not necessarily sandy. It is important also that the soil should be rather rich, in order to insure as far as possible a satisfactory growth of the trees.

The details of propagating the peach begin with the pits or seeds from which the stocks are grown, and on which the different varieties are budded. The pits are obtained by nurserymen from many different sources. They are handled in different ways, depending quite largely upon climatic conditions, the extent of the business, and other factors.

In the middle latitudes, where probably the largest peach nurseries are located, the pits are generally planted in the fall in rows 3 to 4 feet apart where the trees are to be grown. In the North the pits are sometimes stratified or bedded in the fall in moist sand, where they are under some degree of control, and the planting is delayed until spring. In either case the action of the moisture and freezing temperatures results in the cracking of the "stones." If the pits have been stratified, the kernels are usually sifted from the stones and sand before planting. They are then handled in essentially the same manner as pits that are planted in the fall.

In very mild climates, where there is little action from frosts or freezes, it is probably quite important to prevent the pits from ever becoming dry. If they are not planted as soon as they are removed from the flesh of the fruit, they should be held in such a manner as to prevent the loss of much moisture. Otherwise, a very slow and irregular germination would follow. However, pits that have become dry will frequently germinate fairly well without freezing, provided they are soaked in water for a sufficiently long time before being planted.

The usual method of propagation is by budding,[1] and the seedlings should be large enough to bud by midsummer in their first season's growth. This is done largely during July and August, extending sometimes into September. The buds put in during these months should "take," that is, become attached to the stock, within a comparatively few days if the operation is successful; then they should remain dormant until the following spring. After the buds "take," it is a common practice to "lop over" the tops of the seedling stocks by cutting them nearly off just above the point where the bud was inserted. Subsequently the tops are entirely removed, or the tops may be left until the following spring and then removed without being previously lopped over.

[1] The operation of budding is fully described in Farmers' Bulletin 157, entitled "The Propagation of Plants," a copy of which will be forwarded without cost on application to the Secretary of Agriculture.

The trees are ready to be planted permanently in the orchard after they have made one season's growth in the nursery. These are known as "1-year-olds," and they comprise the great bulk of the trees that are delivered by nurserymen for fall and spring planting.

A limited amount of budding is done by some nurserymen in June. Buds inserted as early in the season as this are expected to start into growth with but little delay instead of remaining dormant until the next spring, as is the case with the buds that are put in later in the summer. The trees so grown are termed "June buds" and are ready for permanent planting the following fall. While some growers plant this grade of tree with a high degree of success, the majority prefer 1-year-old trees, as already stated. Trees older than one year should not be planted unless in very exceptional instances.

In California the stocks which are budded during the summer are sometimes used the following fall and spring for planting orchards. This practice is commonly referred to as "dormant-bud" planting.

REGIONS FROM WHICH TO OBTAIN TREES

The section of the country from which trees are obtained is unimportant so long as the trees are well grown, healthy, and typical of the desired varieties. The growing of good trees depends upon favorable conditions and proper management in the nursery, and these factors are not peculiar to any particular section.

The inherent qualities of a variety do not change when the trees are grown in different sections of the country. If the variety is hardy, it will continue to be so; if it is susceptible to some disease, it is not made less so by growing the tree during its nursery period in some particular region.

For economy in transportation trees should be purchased as near the place where they are to be planted as practicable. Moreover, trees shipped long distances sometimes suffer injury if they are not properly packed or if they pass through severe extremes of temperature while in transit. Other things being equal, the nearer the nursery the shorter the period during which the trees are out of the ground. On the other hand, differences in the price of trees of the same grade offered by different nurserymen, the desire to secure trees of some special varieties, or some other reason may make it preferable to purchase elsewhere than at the nearest nursery.

TREES FOR PLANTING

As a rule, only thrifty, well-grown, well-rooted, 1-year-old or "June-budded" trees free from injurious insect pests and fungous diseases should be planted. Thrifty, well-grown trees are not necessarily the largest trees which can be found in a nursery. Medium-sized trees are probably fully as desirable for planting as the larger ones, but the smaller grades in some cases may be made up of trees that are stunted and weak from some cause or other. Not infrequently they have poor root systems. The smaller trees can usually be bought at a lower price than the medium-sized and large ones, but they may prove costly in the end, especially if they are lacking in vitality and make a poor growth after being planted.

Peach trees are commonly graded according to their height. In properly grown trees, however, there is a pretty definite relation between the height and the size of the trunk or "caliper" of the tree. The diameter of the stem is sometimes used as the basis for grading nursery stock. The grades, according to height, are designated as "3 to 4 foot," "4 to 5 foot," "5 to 7 foot" trees, etc. Figure 3 shows four trees of each of three different sizes or grades. The relative size and height are apparent. The heaviest grade (C) is composed of larger, more heavily branched trees than the smaller ones; but they are more bulky and heavier to handle, and it is a question whether they will develop into any better trees ultimately than the medium-sized grade. The smallest grade (A) is composed of fairly good trees, but some of them may be lacking in vitality. Sometimes, for the sake of reducing the first cost, a grower buys even smaller trees than the 3 to 4 foot grade, but in most cases this proves to be false economy. A few cents per tree of additional cost means comparatively little in the initial expense of starting an orchard, but it may mean a vast sum later in the life of the orchard in the better development of good, vigorous trees.

Before planting an orchard, every prospective peach grower who has important interests at stake should form an accurate conception of what constitutes good nursery trees in every respect; he should thoroughly famil-

iarize himself with the appearance of the insects and diseases that are likely to be disseminated on nursery stock; and he should give particular attention to the character of the roots and their freedom from such troubles as crown-gall and aphis injury.

TIME OF PLANTING

In general, in northern latitudes, or wherever the winters are rather severe, planting in the spring as early as the soil can be worked to advantage and after the danger of hard freezes is past is to be advised. But in middle and southern latitudes and in regions generally where the winters are mild and where the fall season is favorable for working the soil until late, the planting of trees in the fall is generally successful and by many is preferred to spring planting. The planting should be delayed until thoroughly well and naturally ripened trees can be obtained, but it should be done before the advent of really cold weather. Fall-planted trees should reestablish some root action in their new positions before winter sets in. The danger of winter injury is thus reduced. But in some of the milder portions of the country, where the soil seldom freezes deep and rarely remains frozen for more than a few days at a time, peach trees are commonly planted at almost any time during the winter.

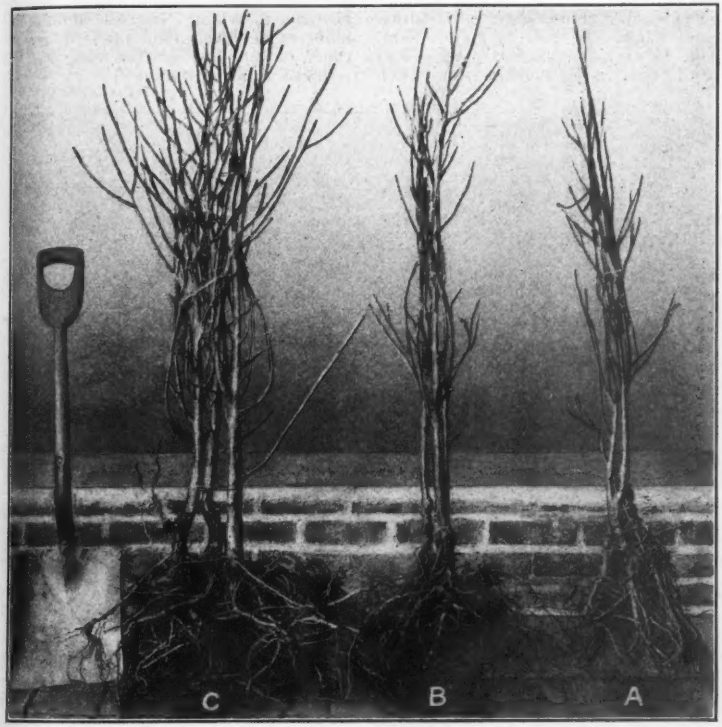

FIG. 3.—Nursery stock, showing different grades or sizes of 1-year-old peach trees: *A*, 3 to 4 foot grade; *B*, 4 to 5 foot grade; *C*, 5 to 7 foot grade

In many parts of California, after the first rains have moistened the soil, usually early in January, the planting may be done to advantage, though some soils may be too cold and uncongenial at that time. In such cases planting is usually deferred until early spring, though there is then some

danger of the trees starting into growth before the soil reaches a suitable condition to be properly handled.

HANDLING THE TREES WHEN RECEIVED FROM THE NURSERY

When received from the nursery the trees should be unpacked immediately. Every possible precaution should be taken to prevent the roots from becoming dry. Unless the trees can be planted immediately, they should be heeled in, in a thoroughly well-drained place, where the soil is mellow and deep. A trench sufficiently wide and deep to receive the roots is made; then the trees are placed in it in the manner shown in Figure 4. In covering, the soil should be worked among the roots of the trees sufficiently to fill all the spaces between them. This will fully exclude the air; otherwise, there is danger of the roots drying unduly. If a large number of trees are to be heeled in at the same place, it will usually be found convenient to place them in closely adjacent rows. When this is done, the trees in one row, for convenience, may be covered with the soil which is removed in opening the next adjacent trench.

Trees that are tied in bundles when received must be separated before being heeled in. If this is not done, it is practically impossible to work the soil among the roots sufficiently well to prevent them from drying to a serious extent.

Sometimes it is necessary to leave the trees heeled in over winter. It is then well to place them in a position which is nearly horizontal, so that the entire portion of the trunks below the branches can be readily covered with soil for the purpose of protection. Such protection is of particular importance in the colder peach-growing districts. The soil should be made rather firm about the trunks and roots, so that harbors for mice will be reduced to a minimum.

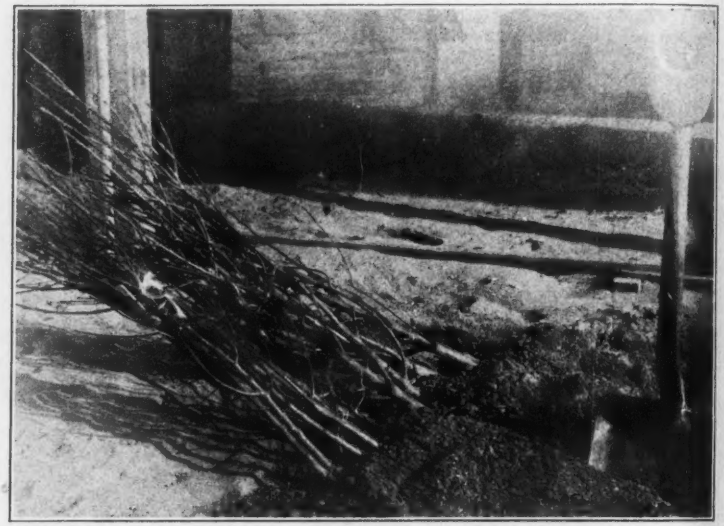

FIG. 4.—Peach trees heeled in. They may be held in this manner in good condition for a long time

PREPARATION OF THE LAND

The ideal preparation of the soil for peach trees consists of deep plowing and thorough pulverizing with the harrow or cultivator, though a certain amount of variation from this ideal may not result disastrously. For example, where newly cleared land is to be devoted to peaches, it is practicable to remove the stumps from a narrow strip along the line of each row of trees, thus making possible a thorough preparation of the strip before the trees are planted and permitting thorough tillage throughout the following season. Each season thereafter the cleared strip should be

widened and the cultivation extended. By the time the trees come into bearing, the stumps should be pretty well cleared from the entire area.

Newly broken sod land can not be as readily fitted for the planting of trees as land that has been plowed long enough for the sod to become well rotted.

PLANTING THE TREES

Peach trees are planted at various distances apart, the topography of the land, the fertility of the soil, the varietal characteristics of the trees, and the preferences and conceptions of individual growers all being factors to be considered. Common planting distances are 18 by 18 feet, 18 by 20 feet, or 20 by 20 feet, requiring, respectively, 134, 121, and 108 trees per acre. Closer planting is sometimes practiced, but it is rarely advisable, and under some conditions 25 by 25 feet probably does not allow the trees more space than they need. The trees are usually planted in squares, as the above distances suggest, but the triangular system or some of its modifications is occasionally used.

Every reasonable care should be observed to plant the trees in straight rows and in perfect alignment in both directions. Trees so placed look better and can be cultivated better and more conveniently than where the rows are crooked and irregular.

Before digging the holes for the trees, some growers plow one or two deep furrows along the line which marks each row, thus greatly reducing the amount of digging that must be done with a spade at the points where the trees are to stand. The holes should be broad enough to admit the roots without bending or crowding them from their natural positions, and deep enough to allow the trees to be planted an inch or two deeper than they were in the nursery.

The use of dynamite in preparing the holes where trees are to be planted has been extensively advocated, but if a soil is well suited to peach growing, it is a question whether dynamiting will improve it materially. If the soil is not adapted to peaches, it is a question whether dynamiting can accomplish any permanent good. Moreover, under some soil conditions positive harm may result.

In some sections a thin stratum of hardpan or other impervious material occurs below the topsoil, while the subsoil beneath the impervious stratum is well suited to peach growing. Undoubtedly the use of dynamite as a means of breaking up such strata is entirely practicable and effective when it is properly applied.

In preparing a tree for planting, all portions of the roots which have been mutilated in digging the trees or injured by any other means should be trimmed off, and long slender roots, if they occur, are usually cut off to correspond with the length of the general root system.

Unless a tree is rather large, the branches should all be removed, leaving only a single unbranched stem, as shown in Figure 5, *A*. This stem should be headed back to correspond with the height at which it is desired to form the head of the tree. The common extremes as to height of top preferred by different growers range from about 12 to 18 inches up to 24 or 30 inches.

But if the larger grades are planted—those, for instance, which are 6 feet or more in height—it is usually safer not to trim to a single unbranched stem. There might, then, not remain enough buds which would give rise to branches properly placed to make a good symmetrical head. It is therefore wise to select from three to five branches that are well distributed about the main stem, from which to develop the head. The limbs thus selected for the foundation of the top should be headed back to mere stubs, as shown in Figure 5, *B*, but on each stub there must be left at least one well-developed bud to insure a starting point for the growth of the branch. With small and medium-sized grades there is little danger that an abundant growth of desirable character will not develop from the main stem.

Danger that the roots may become too dry after they are trimmed and before the trees are planted can be largely eliminated by dipping the roots in a puddle of clay of such consistency that a thin layer of mud will adhere to them when they are dipped into it. Such a coating of mud will afford considerable protection against undue drying out from exposure to sun and wind.

In filling the hole after a tree has been put in position and properly aligned, only finely pulverized soil should be used. Much care should be taken to work the soil in closely about the roots. This may be done to some extent with the fingers. Moving the tree up and down very slightly after the first few shovelfuls of soil have been placed in the hole will also help materially to settle it among the roots.

As the filling progresses, the soil should be firmly tamped about the roots either with the feet or with some sort of a plunger. The soil around the tree should be left about even with the general level of the surrounding surface.

TILLAGE

Tillage refers to the working of the soil after the trees are planted. The objects of tillage have been comprehensively summarized as follows:[2]

(1) Tillage improves the physical condition or structure of the land (*a*) by fining or comminuting the soil and thereby presenting a greater feeding surface to the roots; (*b*) by increasing the depth of the soil and thereby giving a greater foraging and root-hold area to the plant; (*c*) by warming and drying the soil in the spring; (*d*) by reducing the extremes of temperature and moisture; and (*e*) by supplying air to the roots.

(2) Tillage may save moisture (*f*) by increasing the water-holding capacity of the soil; (*g*) by checking evaporation.

(3) Tillage may augment chemical activities (*h*) by aiding in setting free plant food; (*i*) by promoting nitrification; (*j*) by hastening the decomposition of organic matter; (*k*) by extending these agencies (*h*, *i*, and *j*) to greater depths of the soil.

If the tillage is sufficient to maintain the physical condition of the soil and to conserve the soil moisture adequately, the other objects also probably will be realized. An orchard should be tilled, if at all, for the sake of the trees and their product. If without tillage the proper soil conditions exist to an extent which is adequate for the needs of the trees and the production of good crops, then perhaps nothing is to be gained by tillage.

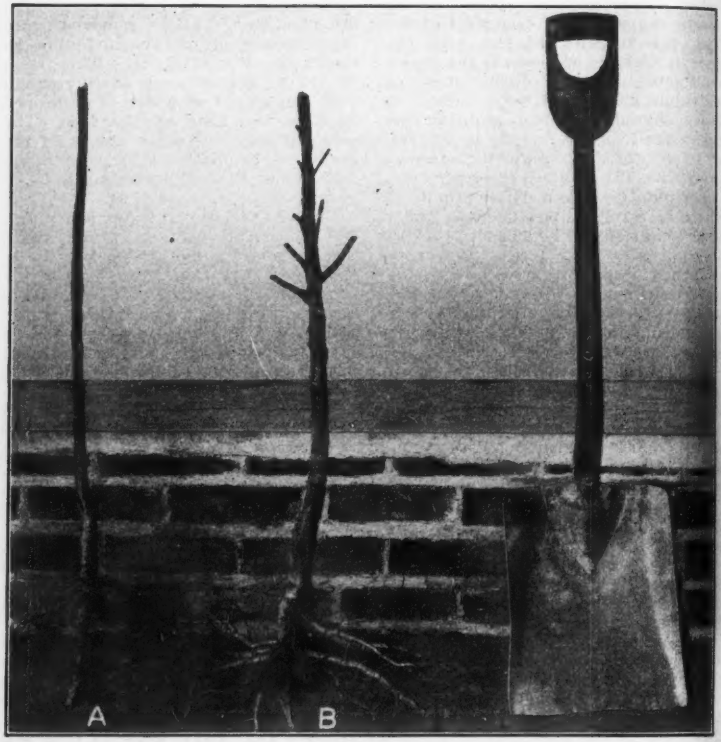

FIG. 5.—Peach trees trimmed ready to plant: *A*, 4 to 5 foot grade; *B*, 5 to 7 foot grade

[2] Bailey, L. H. The Principles of Fruit Growing, p. 76. New York and London, 1915.

With reference to peach orchards, there is comparatively little difference of opinion in regard to tillage. The conviction of the best growers in practically all peach-producing sections is that thorough tillage is essential to the continued successful maintenance of a peach orchard.

To one grower "thorough tillage" may mean plowing the orchard in the spring and harrowing it once or twice later in the season; to another, who has a very high estimate of tillage as a means of preventing the evaporation of moisture from the soil, it may mean going over the orchard with some tillage implement 20 or 25 times during a dry season.

Generally speaking, a peach orchard should be tilled throughout its entire life, beginning with the first season after the trees are planted. If for the sake of economy or for other reasons it is impracticable to work the entire area between the trees, it is usually feasible to confine the tillage for the first year or two to a narrow strip along each row. But the width of the tilled strip should be extended each season, and by the third year the entire surface should receive attention. By that time the roots of the trees extend beyond the spread of the branches, and the entire space between the rows, where the trees have been planted the usual distances apart, is rapidly becoming filled with small rootlets and root hairs through which moisture and plant food in solution are taken up. The root development of peach trees, indicating the position of the roots with regard to tillage and the application of fertilizers, is suggested in Figure 6.

Under normal or standard conditions in most peach-growing districts the advice applies generally, to begin the tillage in the spring as soon as the soil is in suitable condition to work. But in the case of bearing orchards some of the most experienced growers wait until after the fruit has set before they begin, in the belief that earlier tillage may influence adversely the setting of the fruit. The presence of a cover crop, its character, and the needs of the soil with reference thereto are other factors that may influence the date of beginning of tillage. The handling of cover crops is discussed on another page.

If the soil is hard or if there is a cover crop that has made considerable growth, it will be necessary to turn the soil with a plow and follow with a harrow, cultivator, or such other tillage implement as best suits the needs of individual orchards. If the

FIG. 6.—A peach tree about 5 years old growing in "Porter's red clay" soil, Virginia. The spread of the branches was 18 feet. The spread of the roots, as traced, was 36 feet—17 feet on one side and 19 feet on the other

soil is light, plowing in the spring can sometimes be omitted, as some type of cultivator will be found adequate to pulverize thoroughly the soil to a sufficient depth. The surface should be kept as nearly level as possible. For instance, if the soil is plowed toward the trees at one time, it should be turned away from them at a later plowing.

Frequent tillage to maintain a dust mulch 3 or 4 inches deep as a means of conserving soil moisture has long been emphasized. In extensive studies of moisture requirements and conservation carried on by the Office of Dry-Land Agriculture of the Bureau of Plant Industry it has been shown that loss of soil moisture through evaporation from the surface as a result of capillary action, except where the supply is constantly replenished, as by a water table within a few feet of the surface, is very small compared with the loss through the growth of weeds. Besides, every grower is familiar with the difficulties encountered in "wetting up" a dry powder. A dust mulch presents similar difficulties with respect to absorbing the rainfall. The best tillage for conserving soil moisture is that which controls weeds, maintains the soil surface in a fine lumpy or granular condition so that rains are readily absorbed, and sufficiently stimulates the activities in the soil that render plant foods available.

Tillage operations are usually continued until midseason—the last of July or the first of August. By that time the growth of the trees for the season will have been largely made, fruit buds for the next season's crop will have begun to form, the fruit of the midseason varieties will have completed a large proportion of its growth, and the later varieties will finish their development during a period when less moisture is required for the various functions of the tree than earlier in the season. Where cover crops or green-manure crops are desired, they should be sowed, in many cases, by this time.

As the trees become large, some of the extension types of tillage implements are advantageous, as they make possible the working of the soil under the branches without unduly crowding the team into the trees. In one of the large mountain peach orchards in West Virginia, where the broken topography of the land requires strong motive power for efficient work, the outfit shown in Figure 7 has proved especially well adapted. The team of leaders is driven by a "jerk line," the driver riding the near pole horse. The man who rides the harrow not only serves the useful purpose of weighting it down, so that it will cut deep, but he also guides the harrow past the trees by properly adjusting the positions of its two sections. In this way the trees are rarely injured, and yet the harrow can be run very close to them. However, in this particular orchard the use of the harrow is usually preceded by two or three bouts with a light 1-horse plow along each row of trees.

The homemade leveler shown in Figure 8 is also a very useful tillage

FIG. 7.—An efficient outfit for the tillage of orchards where the topography is much broken and the draft is heavy

implement in some orchard districts. Though of special importance in some of the irrigated districts for leveling the irrigation furrows, it is effective in crushing clods and in smoothing the surface of the soil. It consists of two sidepieces of 2-inch plank, 12 or 14 feet long and 6 to 8 inches wide. The crosspieces are 7 or 8 feet wide. The lower edges of the crosspieces where they come in contact with the ground are protected with strips of iron or steel to prevent undue wearing and also to give increased efficiency.

MAINTAINING THE FERTILITY OF THE SOIL

Good tillage and the maintenance of an ample supply of humus or decaying vegetable matter in the soil will do much to keep it in a sufficiently productive condition for peach growing. But continuous tillage of the soil tends to deplete its content of humus unless it is renewed from time to time.

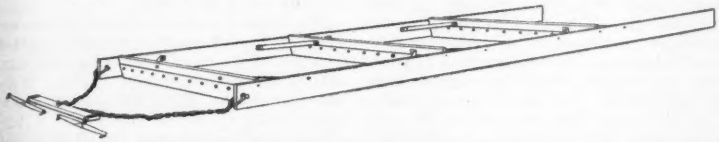

FIG. 8.—A leveler used in some sections for filling irrigation furrows, making the surface of the soil smooth, and pulverizing the clods

USE OF COVER CROPS

Where stable or barnyard manure is abundant there is probably no more satisfactory way of supplying humus to the soil than by a liberal use of it. Manure is seldom obtainable, however, in sufficient quantity to meet any far-reaching needs. In its absence the use of cover or green-manure crops is to be advised.

The ways in which a cover crop may contribute to the welfare of the orchard have been enumerated as follows:[3]

(1) It protects the land and directly improves its physical condition; prevents hard soils from cementing or puddling; holds the rains and snows until they have time to soak away into the land; dries out the soil in spring, making early tillage possible; prevents washing in winter; and sometimes serves as a protection from frost.

(2) It improves the chemical condition of the soil; catches and holds some of the leaching nitrates; adds humus to the soil; renders plant foods available; appropriates nitrogen, if it is a leguminous crop.

The plants commonly used for cover-crop purposes fall into two groups—leguminous (or nitrogen-gathering) and nonleguminous. The former group comprises red clover, crimson clover, bur clover, field peas, vetch, cowpeas, and others; the nonleguminous group consists of rye, oats, buckwheat, millet, rape, turnips, and various others. Sometimes the growth of weeds or other more or less spontaneous growth is encouraged after the seasonal cultivation is ended, as a means of obtaining a cheap supply of vegetable matter for the soil.

Red clover is more commonly used in apple orchards than in peach orchards, and especially when it is intended to omit tillage for a season. Vetch is apparently being used more and more as an orchard cover crop in the northern fruit districts. Crimson clover is especially satisfactory in some of the light soils in New Jersey and Delaware in seasons when there is a good supply of moisture in the soil at the time of seeding. Cowpeas are very widely used for this purpose in middle and southern latitudes.

Probably rye is the most widely used nonleguminous plant. It can be sowed late in the season, and it lives over winter and starts into growth early the next spring. All of these points are important considerations in many instances. But oats in combination with vetch have been especially satisfactory in some cases, and German millet has been shown to be almost an ideal nonleguminous cover crop under some of the conditions that prevail in Nebraska.[4]

In starting the cover crop, the usual practice is to sow the seed when the orchard is given its last cultivation for the season, usually in July or early in August, though the exact time is regulated by conditions. Sometimes cowpeas are planted in drills in June and tillage continued with a small cultivator. Where rye is used, it is

[3] Bailey, L. H. Op. cit., pp. 113–114.
[4] Emerson, R. A. Cover crops for young orchards. Nebr. Agr. Exp. Sta. Bul. 92, 93 p., 12 fig., 1906.

commonly put in toward the close of the growing season.[5]

When a cover crop is used in a peach orchard it should be plowed under as early in the spring as practicable, unless the growth that is on the ground can be worked into the soil effectively and more conveniently by the use of a disk or cutaway harrow. However, if there is an abundance of moisture in the soil, the turning under of the cover crop is delayed in many cases until after it has made considerable growth in the spring, in order to obtain as large a quantity of vegetable matter to be worked into the soil as is possible.

The use of cover crops is sometimes limited in particular seasons by lack of moisture. If there is a protracted drought at the time the seed should be put in and the trees are suffering therefrom, it might do more harm than good to make a further demand upon the moisture in the soil by sowing a cover crop, even though the soil may be known to lack humus.

In certain districts of generally low precipitation in which peaches are being grown successfully, continuous clean tillage, with the return of practically no vegetable matter to the soil, is bringing the ground into poor physical condition. Stable manure as a source of humus is not to be had in sufficient quantity to be of any real value, and the limited moisture supply is not sufficient to maintain the peach trees and grow a cover crop at the same time. This situation as it exists in some districts presents serious problems. The growers are beginning to realize its import.

Likewise in some irrigated districts where the water supply is limited, the need of a cover crop may have to be disregarded, either habitually or in seasons of unusual water shortage, because there is not enough moisture to meet the demands of both the trees and the cover crop.

Aside from maintaining the fertility of the soil, cover crops may have important functions in other respects. Where the soil is subject to washing, a cover crop which survives the winter will often prevent or materially lessen the washing that would otherwise occur.

If good tillage and the wise use of cover crops fail to produce the best results in a peach orchard that is well situated, the use of commercial fertilizers may then logically receive consideration as a last resort.

USE OF FERTILIZERS

There is no "best" fertilizer for peaches, and no particular fertilizer can be recommended. A fertilizer which is economical to use and which gives maximum results in a particular orchard might be without appreciable effect in another orchard.

In maintaining soils in a highly productive condition it is important to learn what factors are limiting the performance of the orchard. The limiting factor may be an insufficient supply of some kind of plant food, improper physical condition of the soil due to a lack of humus or poor drainage, or it may be something else. The real problem is to determine what the trouble is and then apply the proper remedy, if it is known.

Fertilizers are often largely without appreciable effect if they are applied to soils that are in poor physical condition, as when they are greatly lacking in humus. For this reason attention should be given to the use of fertilizers only after the possibilities of tillage and the maintenance of the soil in good physical condition have been exhausted.

It follows that a complete fertilizer may give excellent results. But if there is an insufficient supply of only one plant food, then it may be assumed that the response from the fertilizer is due to the presence in it of that plant food of which there was an insufficient supply in the soil and that the other plant foods in the fertilizer were without any real value to the crop or trees. Obviously under such conditions a complete fertilizer would not be economical.

The wiser plan is to carry on a few experiments with a view to determining local needs. A representative portion of the orchard may be selected. To a few trees—perhaps 5 or 6—nitrogen may be applied; to other trees, potash; and to still others, phosphoric acid. Different combinations of these plant foods, including one which has all of them, thus making a complete fertilizer, may be applied to other groups of trees.

[5] The amount of seed of the various cover crops commonly sown per acre is as follows: Red clover, 10 to 15 pounds; crimson clover, 12 to 16 pounds; bur clover, 20 pounds; field peas, 1½ to 2 bushels; vetch, 1 bushel (60 pounds); cowpeas, 1 to 2 bushels; rye, 1½ to 2 bushels; oats, 2 to 2½ bushels; buckwheat, one-half to 1 bushel; millet, 1 to 1½ bushels; rape, 3 pounds; turnips, 3 pounds.

If a detailed record is made of the different applications and each group of trees treated the same way each season for several successive years, gradually the results of the different fertilizer treatments will become apparent in the behavior of the trees, their growth and vigor, the productiveness and regularity of the crops, the quality of the fruit, and in other ways. From such results the grower who has carefully studied the conditions should be able to decide upon a rational basis for the use of fertilizers in his own orchard.

IRRIGATION

Most of the peaches produced in the Intermountain States and west of the Rocky Mountains are grown under irrigation. It is not feasible, however, to discuss the details of irrigation in this bulletin. Attention is called to Farmers' Bulletin 882, entitled "Irrigation of Orchards," which will be forwarded without cost by the Office of Information, United States Department of Agriculture.

PRUNING

As a general proposition the most successful fruit growers habitually prune their trees, and in doing it they usually follow more or less closely some plan or system, even though they may have no clear-cut conception of just what their plan involves.

The principal objects sought in pruning may be summarized as follows:

(1) To modify the vigor of the tree.
(2) To keep the tree shapely and within bounds.
(3) To make the tree more stocky.
(4) To open the tree top to admit air and sunshine.
(5) To reduce the struggle for existence in the tree top.
(6) To remove dead or interfering branches.
(7) To renew the vigor of the tree.
(8) To aid in stimulating the development of fruit buds.
(9) To secure good distribution of fruit buds throughout the tree.
(10) To thin the fruit.
(11) To induce uniformity in the ripening of the fruit.
(12) To make thorough spraying possible.
(13) To facilitate the harvesting of the fruit.

The pruning which a tree receives during the first two or three years after it is planted has much to do with its future. Mistakes in forming the head or the results of neglect during the early years in the life of a tree are practically irreparable. On the other hand, if the tree is well formed and properly pruned during its first years, the foundation for a good tree is established; subsequent errors in pruning, if they occur, may admit of correction without permanent harm to the tree.

In general, the proper time to prune peach trees is during the dormant period, preferably in late winter or early spring, just before growth starts, except in regions where bleeding from wounds is likely to occur. In such regions it should probably be done in early winter. But conditions and the object of the pruning must be considered in each case. If the pruning operations are very extensive, it may be necessary to prune throughout the winter whenever the weather is suitable for men to work in the orchard. If the fruit buds are endangered during the winter by adverse temperatures, it may be advisable to delay pruning as much as economic conditions permit until settled spring weather arrives. This is especially advisable if heavy heading back of the previous season's growth is desirable for the sake of the tree, since if a large proportion of the fruit buds are killed it may be best for the prospective crop not to cut back heavily.

A limited amount of summer pruning can usually be done to advantage. The trees should be observed constantly throughout the season of active growth. Whenever a branch is seen to be so placed that it obviously will need to be removed at the annual pruning for the shaping up of the tree, it is well to take it off at once. In this way the annual pruning can be reduced to a minimum and the removal of large limbs will rarely be necessary.

Then, too, it frequently happens that a single branch in the top of a tree will grow considerably faster than any of the others, making the tree unsymmetrical if the growth of the branch is not checked. A slight heading in as soon as such a tendency is apparent will usually keep the top well balanced.

The pruning of a peach tree at the time of planting it has already been discussed. A tree well along in its first season's growth is shown in Figure 9. It will be observed that the top is formed of four main branches. This tree shows evidence of having received attention during the earlier part of the season. Only those branches which were of importance in forming the top have been allowed to develop. The exact number of branches which may be used in forming the head is not an arbitrary mat-

ter. From three to five branches are permissible if they are well placed and properly distributed on the main stem of the tree. The branches that form the head of the tree shown in Figure 9 start from points on the trunk which are rather too close together. If there was more space between the branches where they join the trunk there would be less danger of the limbs breaking down in later years from the weight of heavy loads of fruit.

FIG. 9.—A peach tree of the Muir variety during its first season's growth. The cross lines shown in the figure are intended to suggest suitable points at which to cut the branches when the pruning is done later on. (Photographed in California, Aug. 27, 1913)

During the dormant period between the first and second year the first year's growth, provided it has been thrifty and vigorous, should be headed back rather heavily; perhaps one-half or two-thirds of the growth should be removed. The cross lines shown in Figure 9 suggest suitable points at which to cut the branches when the pruning is done later on. However, this needs to be considered with several things in view: The symmetry of the tree, its strength and vigor, and its future development. In order to provide for an open, well-formed head in later years, it may be necessary to thin out some of the smaller, secondary branches. In doing this, however, provision must be made for a uniform distribution of limbs so spaced that the open top desired will be insured and yet the main limbs still carry an ample number of secondary branches.

Pruning the second and third years does not differ in principle from that which follows the first season's growth. At each pruning the previous season's growth is headed back, though perhaps not quite as much as at the first pruning. This, however, will depend upon the character of the growth and the condition of the tree. If it is stocky and strong less heavy heading back will be required to serve the end in view, but long, slender, spindling growth should be shortened back as severely after the second or third season as at the earlier pruning.

At each subsequent pruning the secondary branches require the same attention as at the first pruning. The points which require particular attention are thinning out enough to keep the top open and shortening in heavily in order to produce a new growth of bearing wood evenly distributed throughout the top of the tree and on the interior surfaces of the main limbs.

The effects of not heading in are shown in Figure 10. The trees here shown are making their second or third season's growth. They were not well headed in at first, and no heading back has been done since they were planted. Besides, the soil is lumpy and in poor tilth, and the trees are making a weak, slender growth. Had they been well headed back, the growth would have been much more stocky, even though the trees were small, and they could be in much better condition to sustain the weight of a crop of fruit than they can pos-

sibly be under the system of management that has been followed.

The tree shown in Figure 11 has been pruned more or less, but it exhibits serious defects. It has not been well headed back, the top has not been properly opened, and the smaller, secondary growth has been entirely pruned from a considerable portion of each of the main limbs instead of being utilized to develop fruit-bearing branches in the center, where its weight can best be supported without breaking the tree. With the bearing wood largely developed toward the outer extremities of the branches and the size of the branches disproportionately small for their length, even a small crop of fruit would be likely to break the tree to pieces very badly. This tree may well be contrasted with the trees shown in figures 12 and 13, which have been pruned with a view to developing the characteristics referred to. The limbs are stocky and well proportioned for sustaining heavy crops of fruit. The interior of the trees is well filled with bearing wood, and at the same time the tops are sufficiently open to admit a full quota of sunshine to practically all the fruit.

FIG. 10.—Peach trees about 3 years old that have not been headed in. The limbs are slender and will probably break badly with the weight of the first good crop of fruit

FIG. 11.—A peach tree that has been badly pruned. The bearing wood is near the extremities of the limbs. The weight of even a small crop of fruit would be likely to break the limbs to a serious extent

By the time peach trees are 3 or 4 years old they should be bearing good crops of fruit. After this they will make a smaller annual growth under usual conditions than during the earlier years. Less heading in is therefore required. In some seasons it may not be necessary to cut back the terminal growth, though to do so will tend, as a rule, to develop the smaller secondary and side branches. This is desirable, for reasons already mentioned. Again, the extent of the heading back will be governed in some seasons by the abundance and condition of the fruit buds. If there has been winter injury or if the buds failed

FIG. 12.—A Levy peach tree 8 years old pruned with a view to developing strong, stocky branches and an open top. (Photographed in California, Aug. 28, 1913)

FIG. 13.—Phillips peach trees 10 years old. These trees have been systematically headed back, and strong, stocky limbs have developed. It is necessary, however, to prop them when very heavily loaded with fruit. (Photographed in California, Aug. 27, 1913)

to form well the previous season, little or no reduction of the previous season's growth will be needed. On the other hand, if the trees made a strong growth, an abundant set of fruit buds developed, and they have suffered no injury, a correspondingly heavy cutting back of the previous season's growth may be advisable in order to thin the fruit as much as is possible by that means.

Peaches are always borne on wood that grew the previous season. Therefore after a peach tree reaches bearing age it is essential so to manage it as to induce a fairly liberal growth each season.

As a general proposition, very heavy pruning will induce a correspondingly large amount of new wood growth. It follows that the weaker growing varieties should be pruned more heavily, relatively, than the very strong-growing sorts.

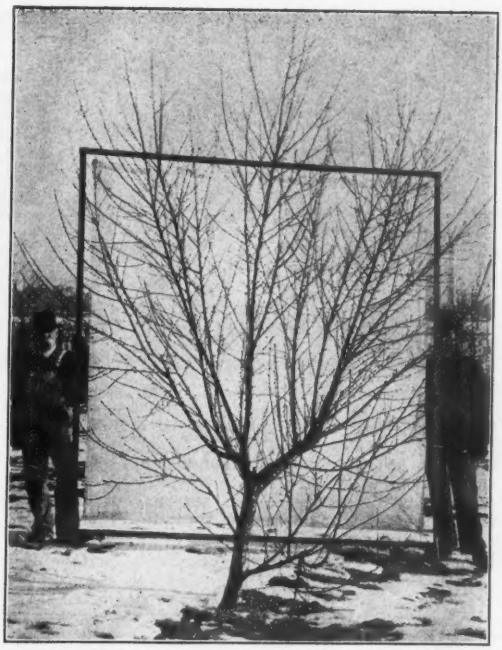

FIG. 14.—A peach tree about 8 years old, before pruning

Some of the details of pruning mature peach trees are suggested in Figures 14 and 15, which show a tree 8 years old before and after it received the annual pruning to make it shapely, remove superfluous wood, and provide for the development of new growth. While the tree illustrated is far from being ideal, as it had not been well handled in previous years, it shows certain important features. The heading back of the main limbs will tend to prevent them from becoming "leggy," and it will induce a good, strong growth of new fruit-bearing wood well within the center of the tree. It may require some thinning out at the next annual pruning to prevent the top from becoming too dense. Probably more wood of the previous season's growth should have been left than is shown in Figure 15, as there ap-

FIG. 15.—The same tree shown in Figure 14 after being pruned

FIG. 16.—Elberta peach trees 14 years old which have been pruned with a view to producing open, spreading tops. The branches of the two trees together in the foreground have an expanse of about 55 feet. (Photographed in Colorado, Aug. 23, 1910)

pears to be only a small amount of surface on which fruit can be produced the following season; but apparently the tree has been put in fairly good condition with regard to its later usefulness.

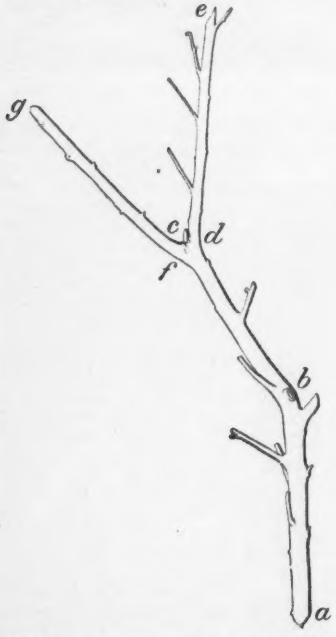

FIG. 17.—A branch which suggests the possibilities of influencing the habit of growth by the position of the bud left at the end when the branch is cut back

The growing of an open-headed tree is not merely a matter of keeping the top well thinned out. The position of the branches can be controlled and directed to a marked extent by the manner in which the pruning is done. Figure 16 shows two Elberta trees which have a rather remarkable spread of limb. Systematic pruning and heading in were practiced in the earlier years of these trees. The spreading habit has been augmented by cutting the branches to outside buds when they were headed back. The significance of this is more clearly shown in Figure 17, which was drawn from life. When the branch was cut back at *b*, during the winter following its growth, the bud nearest the end of the stub was on the outside of the limb. When the branch *b c* developed from that bud the following season, it made a decided angle with the one *a b* on which it developed, thus changing the direction of the growth from that which would have followed the extension of the limb *a b* had it not been cut back and resulting in a considerable widening of the spread of the branches.

The following season, when the pruning was done and the limb *b c* was cut off at *c*, the outermost bud was nearly on top of the stub at *d*. When this bud gave rise to a branch *d c*, the limb *b c* was continued thereby in approximately the direction of the older limb *a b*. The limb *f g*, which developed from a bud at *f* which was not as near the end of the stub as was the bud at *d*, did not materially change the direction of the branch *b c*. Had the bud at *d* been

on the outside, the spread of the branch would have been still more widened, as was the case when the branch *b c* grew from *b*, the latter being an outside bud. If it is desired to correct the habit of growth in the case of a tree that is too spreading to be desirable, cutting back the limbs to inside buds will tend to accomplish the end in view.

Heading in a tree from year to year as suggested, and pruning with a view to producing an open, spreading, low top results not only in the development of strong, stocky limbs well able to sustain heavy loads of fruit, but it brings a large proportion of the top near the ground, where much of the fruit can be harvested without the use of stepladders.

FIG. 18.—Pruning Salwey peach trees in an Allegheny Mountain orchard in West Virginia

The man who prunes a fruit tree during its first years must have a pretty clear conception of what the tree is to look like when it reaches maturity, and he needs to know from the beginning what is necessary each time it is pruned in order to develop the tree which forms his mental vision. A well-formed plan, based on a knowledge of the underlying principles of pruning, is essential if the operation is to be anything more than a haphazard removal of branches that appear to be in the way.

Figure 18 shows a type of stool that is used in one of the Allegheny Mountain peach orchards both in pruning the trees and in harvesting the fruit. The legs spread enough to make the stool stand firm and to give the workman a sense of security when standing on it. When intended for use in an orchard that is located on a very steep slope, the two legs on one side of the stool are made somewhat shorter than those on the other side.

A sled similar to the one shown in Figure 19 is very convenient under some conditions for removing the brush from an orchard after it has been pruned. Another way of disposing of the brush is shown in Figure 20. This device consists of a frame made of piping and lined with sheet iron. It is mounted on iron or steel wheels. The brush is thrown into it and burned as it is drawn through the orchard.

RENEWAL OF THE TOPS

If a peach tree is neglected as to pruning during its early years and the branches are allowed to become long and slender; if, as it attains considerable age, the bearing wood, in spite of the pruning which it has received, has grown out of convenient reach in harvesting, or if for other reasons it

FIG. 19.—A sled used for hauling brush from an orchard. (Photographed in West Virginia)

becomes desirable to renew the top of a tree, it is usually entirely practicable to do so, provided the trunk and main limbs are sound and healthy. Renewal of the top will often result in prolonging the usefulness of a peach tree for several years. This operation is exemplified by several of the accompanying illustrations. Figure 21 shows an 8-year-old peach tree which has become rather "leggy." The annual growth for several seasons has nearly all been made near the extremities of the limbs. Very little new wood has grown in the interior of the tree.

Figure 22 shows the same tree after being severely headed in, or "deheaded," with a view to developing a new top. The small branches which remain on the stubs of the old limbs are an advantage, as they will start into growth more readily than the latent buds from which the new top would have to develop in the absence of small branches of recent growth.

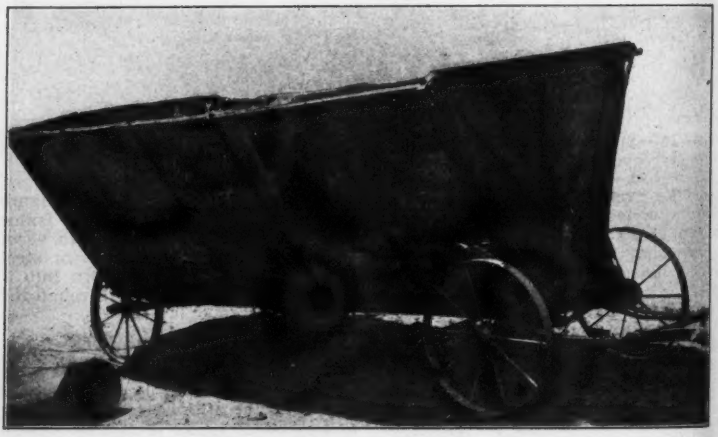

FIG. 20.—A wagonlike device in which the brush pruned from trees is burned as it is drawn through the orchard. (Photographed in California)

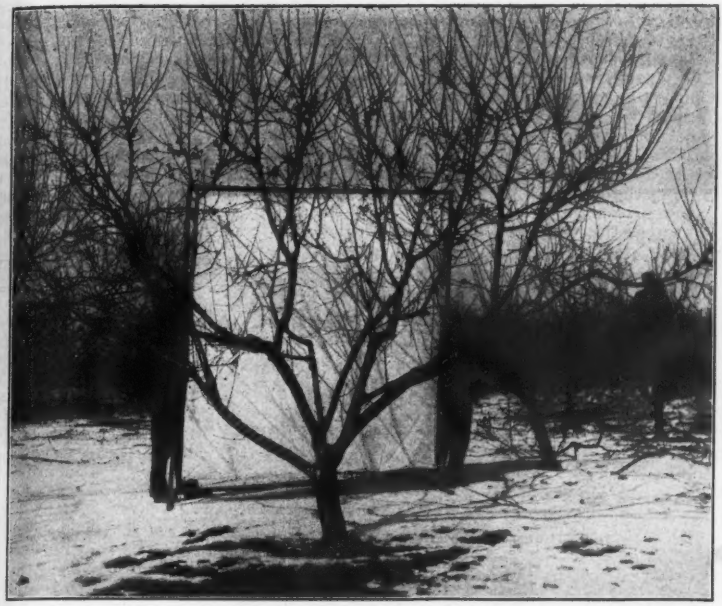

FIG. 21.—A peach tree 8 years old in which the new growth, i. e., the fruit-bearing wood, has been made largely at points far remote from the main limbs

Figure 23 is a third view of the tree shown in Figures 21 and 22, well advanced in its second season's growth after being deheaded. This particular tree was somewhat lacking in vigor; and its growth, following the treatment for the renewal of the top, was not as satisfactory as it otherwise would have been. Figure 24 shows a 7-year-old Elberta tree which was thrifty when it was headed back to about the extent indicated in Figure 22. The illustration shows this tree near the end of its first season's growth after being deheaded. It should bear a crop of fruit the next season.

If a tree which lacks vigor is treated in this way the result shown in Figure 25 may occur. Some of the stubs had no buds strong enough to develop; hence the top was only partially renewed. If the tops are cut back to wood that is not more than 3 or 4 years old, a stronger, more symmetrical growth may be expected than where the stubs left in deheading are older. Occasionally, where the trunk remains sound and retains its vigor, the tops are renewed two or three

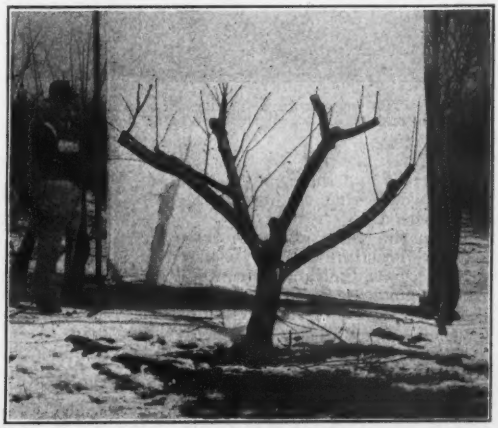

FIG. 22.—The tree shown in Figure 21 after being deheaded

times. As a rule, however, it is impracticable to dehead for renewal more than once.

Sometimes, when for any reason it is desirable to renew the top of a comparatively young tree, the heading in may be made much more severe than that suggested by Figures 22 and 25. This is shown in Figure 26, where all the branches have been cut back to the trunk of the tree.

The season for deheading to renew the top is the same as that for doing the annual pruning for the shaping of the trees and the removal of superfluous wood—that is, during the dormant period.

FIG. 23.—The tree shown in Figures 21 and 22 during its second season's growth after being deheaded

When the vigor of peach trees has been well maintained by good cultural methods, suitable pruning, and wise management in every respect, their life of commercial usefulness is generally from about 8 to nearly 20 years after the full-bearing age is reached. It varies widely, however, under different conditions. In some sections it is rarely profitable to continue them after they reach the age of 12 to 15 years; in others they are expected to last until they are from 15 to 18 or 20 years old, while occasionally an orchard 20 to 25 years old is found which is still of commercial value. Instances of individual trees remaining productive until a much greater age are not uncommon, but they seldom, if ever, represent orchard conditions.

CHANGING THE TOP BY BUDDING AND GRAFTING

Sometimes it is desirable to change the top of a peach tree from one variety to another. A grower may find after his orchard begins to bear that he has a larger number of trees of some variety than he wants; a block of trees may prove to be some other variety than the one ordered; or, for some other reasons, a variety is not well adapted to the needs of the owner. In such cases he may top-work the tree either by budding or by grafting it to a desirable variety.[6]

The ordinary method of shield budding is most commonly used for this purpose. If the tree to be top-worked is not more than two or three years old, it is usually practicable to insert the buds directly into the main limbs well down toward the point where they leave the trunk. This is illustrated in Figure 27, which shows a Triumph peach tree that was budded to the Carman variety when it was 3 years old, after its crop of fruit had been removed. The points where the buds were inserted are shown in the figure.

If the tree to be top-budded has reached the age when the bark on the main limbs has become too thick and firm to be manipulated readily for budding, it is necessary first to head it back somewhat, as when the top is

[6] The operations of budding and grafting are fully described in Farmers' Bulletin 157, entitled "The Propagation of Plants," which will be forwarded without cost on application to the Secretary of Agriculture.

to be replaced with new growth of the same variety, and later insert the buds on the new branches that develop after the tree has been deheaded. When this course is followed, the buds should be inserted in the new growth as near the trunk as is practicable, in order to have as large a portion of the top as possible of the new variety. This is also desirable on account of the subsequent management of the tree.

Top-working is sometimes done by grafting instead of budding, the ordinary cleft graft being generally used.

FIG. 24.—An Elberta peach tree 7 years old that was deheaded about as indicated in Figure 22, showing its first season's growth after being cut back. It should bear a crop of fruit the following season. (Photographed Aug. 15, 1911)

However, budding is to be preferred, especially as the wounds made in grafting do not heal readily in the case of the peach, though when properly done the union of stock and scion is generally strong enough to make a fairly serviceable tree. But troubles resulting from difficulties in the healing of the wounds are likely to occur.

THINNING THE FRUIT

Most varieties of peaches, as well as other fruits, for that matter, under favorable conditions often set much more fruit than the tree can possibly develop to a good degree of perfection for commercial purposes. The natural tendency of the tree is to perpetuate its kind. To this end, left to itself, it develops the largest possible number of seeds, with each seed possessing the possibility of a new tree.

The grower's aim, however, is for the tree to produce the largest possible amount of fruit that can attain the highest commercial standard. The effort of the tree and the object desired by the grower tend to impose incompatible requirements. The development of a great number of seeds is a tree-exhausting process. This is opposed to the development of large fruits. To meet his ends in this respect, the grower has recourse to thinning the fruit.

Perhaps no operation in the production of peaches requires keener judgment than thinning the fruit. No fixed rules for it can be given. A common practice, very generally applicable, is to thin so that the fruits will not be nearer together than 4 to 6 inches. But the strength of the tree, the fertility of the soil, and especially the soil moisture, together with the size of the crop (or, in other words,

the number of fruits allowed to develop on the tree), govern very largely the size and perfection of the individual fruits.

Obviously, a vigorous tree growing under favorable conditions as to moisture, plant food, etc., can develop a larger number of fruits to good size than can a weak tree, or even the same tree when there is a marked deficiency either in the supply of moisture or of plant food.

FIG. 25.—A peach tree that has been deheaded, but which did not develop a symmetrical top because some of the stubs had no buds strong enough to develop branches

The skill of the grower is shown in his ability to adjust the size of the crop on his trees to the conditions of the season. He can reduce the number of fruits on the trees if the season becomes very dry as it progresses. Thus the grower should aim to control the size of the individual fruits by thinning and by tillage and pruning.

While thinning may cost a relatively large amount per tree, actually more high-grade fruit is produced, as a rule, on a tree which bears only a moderate crop than on one which is heavily overloaded, and the average fruit on the tree with a moderate crop is of better grade than the best fruit on an overloaded tree.

The thinning should be done after the "June drop"—which usually occurs from a month to six weeks after the blossoming period, when the imperfectly fertilized and other weakly developed fruits drop off—and before the pits begin to harden. After the "June drop" is over there is very little dropping of the peaches. Hence, practically all the fruit which remains then will be on the trees at harvest time. It will have to be picked then, anyway. It probably costs considerably less to pick a portion of the crop in June or July and drop the fruit on the ground than to pick it later and put it in a basket, where much of it will have to be handled over several times in grading and packing and then finally large quantities discarded as culls because the fruits are so small. Moreover, the fruit on an overloaded tree will sometimes ripen less uniformly than on a tree that has a moderate crop.

As the development of its pits is an exhaustive process, the limiting of the number of fruits tends to conserve the vitality of the tree. A large portion of the flesh of the peach is water; hence, if the soil is well supplied with moisture the development of the edible portion of the fruit makes a relatively light demand on the strength of the tree.

CONTROL OF INSECT PESTS AND FUNGOUS DISEASES

After a grower has pruned intelligently, tilled and fertilized his orchard well, and irrigated it if required, the orchard may be short lived and the crops financial failures if he neglects to give proper attention to the control of insects and diseases, a considerable number of which are to be found pretty nearly everywhere in the sections where peaches are grown.

Emergency matters should be referred to the agricultural experiment station of the grower's State without delay.

Inquiries relating to any phase of fruit growing may also be referred at any time to the United States De-

partment of Agriculture, where, without cost, through the department's experts, as full information relative to the problems as can be given may be obtained.[7]

GROWING CROPS BETWEEN THE TREES

Frequently some annual crop is grown between the trees during the first two or three seasons to help meet the cost of maintenance during the unproductive age of the orchard. This practice is seldom any advantage to the trees in comparison with thorough tillage by itself, but if the crops are wisely selected and properly managed they are not likely to do any serious harm.

The crop ought to be one which needs essentially the same tillage that the peach tree should have, so as not to interfere seriously with that operation. But the grower should realize that he is, in effect, following a system of double cropping and that because of the crop between the trees he may need to give more attention to maintaining the fertility of the soil than he would for the peaches alone.

After the trees reach bearing age they should not be made to compete with another crop. Even if the plant food in the soil is sufficient to produce successfully two crops at the same time, the peach trees usually will need all the available soil moisture, except, of course, in sections where irrigation is practiced and the supply of water is adequate for all purposes. Besides, a crop between the trees would be likely to interfere with the spraying of the trees (if the operation should be necessary), with the harvesting of the fruit, and in other ways.

Muskmelons, beans, peas, cabbages, tomatoes, and other truck crops are extensively grown between peach trees in different sections. Potatoes are sometimes used, but they are suitable only when the crop can be so managed that the digging of the potatoes will not amount to a late cultivation, which may be attended with undesirable results. Corn, also, is frequently used, but as very often managed it is objectionable, because it shades the trees excessively. Whenever corn is used, an open strip of considerable width should be left along the rows, so that the trees will be fully exposed to the sunlight throughout the season. If a very tall, strong-growing variety of corn is used, a wider strip should be left unplanted than where a dwarf variety is selected.

FIG. 26.—A peach tree that shows the possibility of developing an entirely new top when the limbs are cut back to the trunk. This is not likely to be successful except on comparatively young trees

Peach trees are sometimes used for planting between trees, especially where apples comprise the permanent crop. This practice is highly recommended by some and emphatically con-

[7] Publications of value to peach growers in combating insects and diseases and obtainable from the Department of Agriculture on request are: Farmers' Bulletin 908, "Information for Fruit Growers About Insecticides, Spraying Apparatus, and Important Insect Pests"; Farmers' Bulletin 1246, "The Peach Borer: How to Prevent or Lessen Its Ravages; the Paradichlorobenzene Treatment"; Department Bulletin 1169, "Further Studies with Paradichlorobenzene for Peach Borer Control with Special Reference to Its Use on Young Peach Trees"; and Department Circular 216, "Controlling the Curculio, Brown-Rot, and Scab in the Peach Belt of Georgia."

demned by other fruit growers of wide experience. It is probably objectionable in that for a period of years both bearing and nonbearing trees occupy the same area, and it is sometimes desirable to treat a fruiting tree very differently from one that is not fruiting, for the best results with each. On the other hand, where a site is particularly favorable for both fruits, a compromise treatment can often be effected which yields fairly satisfactory results with both kinds of trees.

FIG. 27.—A 3-year-old Triumph peach tree top-budded with the Carman variety after harvesting the season's crop of fruit. This shows the tree about one year after the Carman buds were inserted at *a*, *b*, *c*, and *d*

ORCHARD MANAGEMENT AND WINTER INJURY

In nearly all of the experiment-station bulletins on peach culture, in current horticultural literature, and in the standard works in which peach growing is discussed in detail, emphasis is habitually placed upon the necessity of so managing the orchard that the trees will cease growing and the wood become fully mature before the advent of cold weather. Otherwise, serious winter injury is anticipated. To accomplish this end it is generally advised to cease tillage in July or early August, to withhold fertilizers rich in nitrogen, and to avoid excessively fertile soil in selecting sites for peach orchards.

Undoubtedly such advice is perfectly sound and applicable to a large proportion of the peach-growing districts, but there appear to be some rather marked exceptions that are applicable in important peach-growing sections, to which the reader's attention may well be directed.

These exceptions to the general practice have been brought to light largely through investigations carried on by the Missouri Agricultural Experiment Station.[8] They consist primarily in so managing the orchard as to maintain the trees in active growth until rather late in the season. This may be accomplished by continuing the tillage later than is ordinarily advised, by using a nitrogenous fertilizer, or by heavy pruning, which results in a vigorous growth of new wood. Any condition that seriously reduces the vitality of the tree tends to make the tree, especially the fruit buds, susceptible to injury by winter temperatures. The production of an excessive crop of fruit is a common cause of depleted vitality. The conclusions of the Missouri experiment station tentatively summarized are as follows:[9]

Where nitrogen was applied to peach trees a good crop was produced and harvested. On plats receiving no fertilizer there was practically no crop. There was likewise a failure of peaches in the surrounding region where no fertilizer was applied. The cold winter of 1911–12 was disastrous to peach trees in Missouri. Injury to peach trees caused by the cold so weak-

[8] Missouri Agricultural Experiment Station Bulletin 74, entitled "The Winter-Killing of Peach Buds as Influenced by Previous Treatment."

Missouri Agricultural Experiment Station Circular of Information 31, entitled "Hardiness of Peach Buds, Blossoms, and Young Fruit as Influenced by the Care of the Orchard," being a reprint from the Annual Report of the Missouri State Board of Horticulture, 1908.

Missouri Agricultural Experiment Station Bulletin 111, Report of the Director for the Year Ending June 30, 1912.

[9] Missouri Agricultural Experiment Station Bulletin 111, Report of the Director for the Year Ending June 30, 1912, pp. 247–248.

ened their vitality that disease like the bacterial shot-hole leaf disease was common. On the plats fertilized with nitrogen there was little bacterial disease. On adjacent unfertilized plats the injury from this cause was very great. The trees in the plats fertilized with nitrogen also recovered from winter injury much more successfully and quickly than unfertilized trees in the same locality.

The application of phosphorus and potassium either singly or in combination did not result in increased yields. The results of the investigations on fertilizers for peaches seem to indicate clearly that a nitrogenous fertilizer or a method of cultivation and management which favors a vigorous tree growth when combined with pruning, spraying, and thinning fruit on overloaded trees will increase the crop. The above treatment tends to make them carry their fruit buds through winter and frosts of spring much more safely than where an average or weak growth only is secured. Our results seem to disprove the theory that trees must make their main growth early in the season and then be checked or retarded in their growth in August or September in order to ripen their wood before going into winter. In some experiments at this station where the trees have been encouraged to grow vigorously right up until some of the green leaves froze on the trees, either by the use of fertilizer or by severely pruning back the winter before or by thinning the fruit, they have uniformly carried their fruit buds through the winter much more safely than with trees that shed their leaves and ripened their wood early.

A very careful correlation of these results with the conditions which are generally considered essential in the growth of peach trees in the northern districts is necessary in order to understand their significance. There is no real conflict or lack of harmony in the methods advised for the different regions, though in the abstract they may appear to be directly incompatible.

On the other hand, they illustrate very forcefully the fact that the blind application of definitely stated rules is likely to work disaster. The importance of intelligently adapting the methods used to the conditions which have to be met in different fruit-growing regions is emphasized.

The differences in the conditions in the northern peach districts and in those met in connection with the investigations of the Missouri experiment station are largely differences in the climate during the winter season.

In the northern districts the normal winter is continuously cold and without any warm spells of sufficient duration to affect the dormancy of the trees. It usually remains cold until winter finally breaks. When it warms up enough to start the trees into activity and cause the buds to swell, there is comparatively little danger thereafter of serious frosts or freezes. Moreover, the critical factor—the one which largely governs the management of the orchard in the present connection—is low winter temperatures which are sufficient to kill the buds or injure the trees even when they are perfectly dormant. To best meet this low-temperature factor, it is recognized that the trees must be thoroughly dormant and the current season's growth well ripened.

In regions where the Missouri methods are applicable, critically low winter temperatures are of little concern, provided the trees are in a dormant state. But the winters are characterized by warm spells in December, January, and perhaps in February, which are sufficient to start the buds. This makes them tender and susceptible to injury later in the season by temperatures that are entirely seasonable and which would be of no concern to the peach grower if the buds were dormant. The trees often blossom early and before the season of spring frosts is past.

The reason for continuing the growth of the trees until late in the season in these regions is based on the fact, the practical importance of which is shown in the investigations referred to, that the rest period, or period during which the trees normally remain dormant, is one which by nature continues for a fairly definite period of time. Until that period is past, when once they have become dormant, the trees do not respond readily to temperatures which later would cause them to resume a more or less active condition and might result in the buds swelling enough to make them tender.

This is a matter that is relatively unimportant in regions where the entire winter season is normally characterized by temperatures which are not sufficiently high to affect vegetation, but it has a very important significance in the regions in which warm periods of considerable length occur during the winter. If all the agencies which tend to stimulate the growth of the trees are discontinued relatively early in the season, the trees will cease growing and begin to ripen their wood at a correspondingly early date; the resting period inherently required by the trees is then completed early in the winter. If a spell of warm weather occurs soon after that period is ended, as, for instance, in January, the trees will respond to it; the buds will begin to swell and soon become tender. On the other hand, if the growth of the trees is continued actively by means of late tillage, nitrogenous fertilizers, or in other ways,

until the near approach of cold weather, the period of rest and dormancy inherently required by the trees is not completed until a correspondingly later time in the winter. Under these conditions the trees remain inactive during warm spells in December or January, and the buds do not swell enough to become tender until many of the dangers incident to adverse winter temperatures are past.

While the application of these methods, which have in view the results that follow the continuation of active tree growth until late in the season, may be somewhat restricted, they are undoubtedly worthy of the most careful consideration by peach growers who are located in regions where the winters are characterized by warm periods of sufficient length to cause the trees to become more or less active before settled spring conditions arrive.

There are a few special methods and practices in the management of peach orchards which are of sufficient importance in some sections to justify brief reference to them here.

The Ohio Agricultural Experiment Station has called attention to the efficacy of slightly mounding up the soil about the base of the trees in preventing injury during periods of excessively low winter temperatures. In the same connection it has been shown that various other factors relating to the soil may greatly influence the amount of damage which peach trees suffer during such periods.

The winter of 1903–4 was characterized in the Lake Erie peach district of Ohio by periods of severe and prolonged cold. Great numbers of peach trees were killed. The prevailing conditions and their attendant results on the peach trees are summarized as follows: [10]

> Exceptional causes of susceptibility to cold in rare cases of apparently healthy, vigorous trees: Low, moist, rich black soil which favored an extreme growth of soft, poorly ripened, or matured wood; or high culture upon soil rich in plant food which brought about similar results.
>
> The unusually deep, hard freezing of the earth's crust was due, directly, to the continued, steady cold, but was intensified, in many instances, by a lack of humus or vegetable matter in the soil, which constitutes nature's insulation of the surface of the earth from cold and heat.
>
> Providing that the orchards had been kept free from fungous disease and the San Jose scale by timely and thorough spraying, no injury of trees was found where stable or barnyard manure had been used upon the ground within the last year or two previous to the winter of 1903–4; rarely was an injured tree found standing in sod; no injury was done where the surface of the soil beneath the trees had been covered with even a very slight mulch; little injury was done where the trees stood in fairly well-drained soil containing a moderate amount of fertility and humus; no injury was found where the trees were under the grass-mulch method of culture . . .; no injury was observed in any case where the stems of the trees had been slightly banked or mounded with a few shovelfuls or forkfuls of soil, peat, or manure.
>
> Very few trees which, within the past few years, had been affected with leaf-curl or infested with San Jose scale or borers remained alive or uninjured; and very few trees existing upon infertile or exhausted soil, depleted of humus, escaped uninjured.

The usefulness of a cover crop in preventing the washing of the soil during the dormant period of the trees is frequently well demonstrated. Moreover, in some regions where the winters are rather severe and there is a very limited snowfall, a cover crop prevents the snow from blowing away, thus affording additional protection against the extreme freezing of the roots.

Another practice, which is entirely regional but which may be of considerable advantage at times, is the shading of the trunks of the trees with board protectors, lath screens, or in some other equally effective manner. This method is of use particularly in regions in which long periods of extremely hot weather usually occur and where the trees are not well shaded on the south and southwest sides. Shading in the manner suggested sometimes affords a measure of protection against the form of winter injury commonly called "sun scald." This is generally caused by too rapid thawing after the trunks have been frozen very hard.

[10] Ohio Agricultural Experiment Station Bulletin 157, "Winter-Killing of Peach Trees," p. 132.

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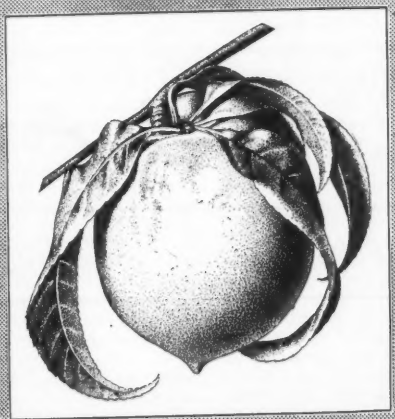
GROWING PEACHES

SITES AND CULTURAL METHODS



IN ITS commercial and economic importance in this country the peach is second only to the apple among deciduous-tree fruits. Commercial peach interests exist in about three-fourths of the States, with some home plantings in most of the others.

The peach grower who has had only limited experience will find in this bulletin information concerning some vital factors which largely determine the success of a peach orchard.

Emphasis is placed upon suitable location and site, because a faulty choice of either may be fatal to future financial success. Some mistakes in planning an orchard can be overcome as the orchard develops, but a poor location or site is beyond remedy.

The basic operations of planting, tillage, maintaining soil fertility, and pruning are discussed in this bulletin.

Farmers' bulletins containing information on the control of peach insects and diseases are cited in a footnote at the bottom of page 27. Farmers' Bulletin 1702, Preparing Peaches for Market, will be of value to many growers.

Washington, D. C.

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GROWING PEACHES: SITES AND CULTURAL METHODS

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DISTRIBUTION AND STATISTICS OF PEACH GROWING

PERHAPS there is no better way of showing the trend of the peach industry during the past 30 years so far as the distribution of orchards is concerned and its present extent than by means of the census figures, which are shown in Table 1. One of the interesting deductions to be made from the figures is the widespread cultivation of the peach. In more than 30 of the 48 States there are peach interests of commercial importance. The limiting factor in the States where few trees are grown is doubtless extremely low winter temperatures. Yet in the milder portions of even these States, especially in protected localities, the growing of peaches is not an impossibility. It is obvious, however, that where the limit of possibility is approached, the number of crop failures may be expected to be large in comparison with the number of good crops.

Wide differences appear in the number of bearing trees in certain States in the different 10-year periods, with a decrease in most cases and a constant decrease from decade to decade in the total number of bearing trees; and the number of trees not of bearing age has not been maintained. Production records, however, show that there has been no significant decline in size of crop, either actual or relative. In fact, the crop of 1931 was the largest on record.

LOCATION AND SITE

The location of an orchard has to do with its general surroundings. It may relate to transportation facilities, markets, climatic conditions, and the geographical position of the district or region in which an orchard is placed, or, in other words, its local geography. The site has to do with the particular piece of land occupied by the trees. It relates to the soil, slope, atmospheric drainage, and other natural factors which affect the suitability of a given area of land for peach growing.

A location may have every natural advantage as to climate, soil, and other local conditions for the successful growing of peaches and yet, because of its remoteness from a shipping station, distance from suitable markets, or even the impracticability of supplying ice for refrigerator cars, it may be impossible to market them profitably. Moreover, a location may have all these advantages to a satisfactory degree and yet not be desirable for commercial peach growing, because the markets within its logical radius for distribution are already abundantly supplied with peaches from districts which in some important respects are more advantageously placed.

TABLE 1.—*Distribution of peach trees by States, as shown by census reports*

State	Trees of bearing age				Trees not of bearing age	
	1900	1910	1920	1930	1920	1930
New England:						
Maine	9,592	5,102	5,666	3,168	2,570	1,880
New Hampshire	48,819	57,571	81,287	40,708	23,200	25,777
Vermont	4,993	5,492	2,915	2,919	3,978	1,412
Massachusetts	301,405	154,592	346,260	182,198	135,426	121,721
Rhode Island	48,063	39,342	61,125	34,299	25,366	23,092
Connecticut	522,726	461,711	495,750	250,678	133,577	128,750
Middle Atlantic:						
New York	2,522,729	2,457,187	3,038,023	1,683,521	658,868	785,698
New Jersey	2,746,607	1,216,476	1,936,632	1,463,108	884,067	320,021
Pennsylvania	3,521,930	2,383,027	3,563,726	2,362,904	1,234,708	1,083,603
East North-Central:						
Ohio	6,363,127	3,133,368	2,924,177	2,356,404	970,183	1,461,539
Indiana	2,925,526	2,130,298	860,024	1,324,844	568,046	604,558
Illinois	2,448,013	2,860,120	1,011,325	2,989,997	839,712	1,037,459
Michigan	8,104,415	2,907,170	2,010,022	2,007,743	764,838	1,173,238
Wisconsin	6,967	4,163	1,522	3,360	1,153	1,246
West North-Central:						
Minnesota	1,626	1,571	890	1,009	427	532
Iowa	516,145	1,090,749	129,939	192,361	61,043	95,162
Missouri	4,557,365	6,588,034	2,358,925	1,611,593	716,325	668,953
North Dakota	2	90	38	63	32	90
South Dakota	1,080	1,815	109	382	177	432
Nebraska	1,055,959	1,188,373	95,629	118,924	40,118	73,529
Kansas	5,098,064	4,394,894	844,498	509,167	278,914	267,164
South Atlantic:						
Delaware	2,441,650	1,177,402	464,514	382,350	93,336	115,027
Maryland	4,017,854	1,497,724	997,086	680,258	285,486	214,225
District of Columbia	149	330	1,208	457	238	253
Virginia	1,939,113	1,585,505	1,578,253	1,443,789	783,733	681,027
West Virginia	1,695,642	1,424,582	2,049,862	1,122,288	651,742	552,721
North Carolina	2,773,788	2,661,791	1,976,756	2,674,922	1,093,993	634,733
South Carolina	1,136,790	1,336,142	871,976	1,161,006	335,599	274,134
Georgia	7,668,639	10,609,119	8,655,051	7,914,134	3,391,851	1,306,190
Florida	354,208	290,850	206,155	139,841	116,913	68,269
East South-Central:						
Kentucky	2,884,193	2,245,402	1,671,044	1,311,431	690,483	854,324
Tennessee	2,749,203	3,163,737	2,349,656	2,747,078	690,359	918,892
Alabama	2,690,151	3,177,331	1,544,700	1,198,131	546,024	492,958
Mississippi	1,856,748	1,726,298	855,158	798,582	493,651	459,425
West South-Central:						
Arkansas	4,062,218	6,859,962	3,342,387	3,238,090	988,966	1,059,834
Louisiana	758,877	903,352	405,178	325,464	231,909	249,084
Oklahoma	[1] 5,848,808	4,783,825	2,879,945	1,384,806	637,762	442,445
Texas	7,248,358	9,737,827	4,461,717	3,077,538	1,640,848	1,313,030
Mountain:						
Montana	1,670	538	1,831	311	420	495
Idaho	79,757	73,080	178,434	95,758	26,648	22,427
Wyoming	9	46	19	55	33	40
Colorado	319,998	793,372	446,943	454,101	32,158	334,565
New Mexico	117,003	136,191	154,968	92,933	36,923	33,266
Arizona	67,073	51,415	101,855	53,038	26,681	18,335
Utah	409,665	544,314	554,202	491,430	28,551	206,197
Nevada	9,136	6,329	5,940	8,129	3,721	2,457
Pacific:						
Washington	226,636	536,875	649,085	532,497	50,254	227,315
Oregon	281,716	273,162	412,936	222,001	29,911	143,267
California	7,472,393	7,829,011	9,057,760	10,222,215	1,366,941	1,633,516
Total	99,916,598	94,506,657	65,646,101	58,911,983	21,617,862	20,134,313

[1] Includes Indian Territory.

It is likewise true that within a district which as a whole is well located for commercial peach growing there may be and usually are sites which are not adapted to this purpose, for reasons that are entirely local. This is especially apt to be the case in mountainous districts or wherever the topography is much broken and soil conditions are very variable. Especially careful discrimination in the selection of sites for orchards is essential in such districts. Figures 1 and 2 show typical orchard sites in im-

portant peach-growing districts in mountainous sections in widely separated parts of the country.

SITES WITH REFERENCE TO SOIL

It is the current opinion that the peach should be planted on sandy or some of the lighter types of soil. Excellent results may follow the planting of orchards on such soils, but peaches do well also on a wide range of soil types, including even some of the moderately heavy clay loams and clays. But whatever the type, a soil must be thoroughly well drained. Peaches will not succeed on poorly drained soils. The heavy clay types which are so hard and impervious that water does not percolate through them readily are to be avoided. Moreover, the soil should be moderately fertile. One very rich in nitrogen is not desirable as a general rule, since it may induce an excessive growth of foliage, but the impression that a poor, infertile soil is "good enough for peaches" is erroneous.

Where alkali soils occur, they should be avoided. While the peach tree can be grown where there is a limited amount of the alkali salts, they cause disaster if present in large quantities. It is safer, therefore, to avoid them as far as possible.

SITES WITH REFERENCE TO ELEVATION

Generally a site that is elevated considerably above the surrounding areas is to be preferred for a peach orchard. Cold air settles to the lower levels. For this reason it is often colder at the lower elevations than it is at high points. This is what is meant by "atmospheric drainage." The occurrence of frost in low places when there is none on elevated areas is thus explained. For the same reason peach buds are often winterkilled or the blossoms are injured by frost in the spring in low places when nearby orchards on higher elevations are injured much less, or even escape entirely. During the past few years the importance of selecting relatively high sites for peach orchards in order to avoid the effects of unfavorable temperatures has been emphatically demonstrated in many different parts of the country. There are, however, certain general exceptions to the foregoing statement. Where an orchard that is well elevated above the surrounding country is exposed to low temperatures which are accompanied by severe winds, the fruit buds are sometimes injured, when in the orchards at lower levels in the same locality, where there is protection from the wind, no injury occurs. However, injury under these conditions is rather rare in comparison with that which occurs in orchards that occupy relatively low sites.

FIG. 1.—A fairly typical peach-orchard site in the Allegheny Mountain district of West Virginia, this being in Morgan County. In many instances the soil and other conditions in the valleys between the ridges are not well suited for peaches, even though the ridges may be admirably adapted to them

SITES WITH REFERENCE TO BODIES OF WATER

When an orchard has a site adjacent to a body of water of sufficient size and depth to have an appreciable influence on the local climate, the importance of a relatively high elevation

largely disappears. Because water warms up in the spring more slowly than the atmosphere it acts, in effect, as a refrigerator, making the temperature in its immediate vicinity colder than at points somewhat distant from it. Vegetation within the zone of this influence advances more slowly in the spring than it does outside of that zone. The tendency is for the blossoming of peach trees within the zone to be delayed until after the season of spring frosts is past.

In the fall frosts are delayed. The water, having absorbed much heat during the summer, cools off in the fall more slowly than the atmosphere and tends to keep the temperature within its zone of influence warmer than it would otherwise be.

For these reasons peaches are grown with marked success in the portions of

FIG. 2.—A fairly typical peach-growing section in a foothill district in California, this being in Placer County. Though the surface is much broken, these orchards are all irrigated

New York and the Province of Ontario that border Lake Ontario, in Ohio along Lake Erie, in southwestern Michigan on Lake Michigan, and in some other districts adjacent to large bodies of water. The influence of such bodies of water usually does not extend back from the shore more than a few miles, though the slope of the land with relation to the water determines largely the extent of the area affected.

SITES WITH REFERENCE TO SLOPE

The slope or exposure of a site has reference to the point of the compass toward which the land inclines. No one slope is preferable under all conditions and in all regions. A site having a moderate slope in some direction probably is to be preferred for orchard purposes to one that is level, as one with a slope will usually have better soil and atmospheric drainage than a level area; but one slope may be as good as another.

An orchard that occupies a site which slopes away from the prevailing wind may be afforded a certain amount of protection therefrom, and in some regions there are well-marked soil differences on the different slopes of the ridges. These differences may be such as to make one slope better adapted to peach growing than another.

The slope factor, however, is largely one of degree. Peach trees on a site having a very steep southern slope will usually blossom and the fruit will ripen somewhat earlier than on a corresponding northern slope, but where the differences in slope are only moderate their relative influence on the time of blossoming and ripening is not very marked. Whether early or late blossoming is desirable is largely a local matter and depends primarily on the relative dates of blossoming and the usual occurrence of spring frosts in any locality or on any site.

TEMPERATURE A LIMITING FACTOR

Aside from economic factors, temperature probably is the most decisive limiting factor in the distribution of commercial peach growing. Usually the fruit buds are the first to suffer injury. No absolute minimum temperature which the peach is able to withstand without injury can be given. The condition of the buds with regard to their strength, vitality, and perfect dormancy, the duration of the critical

temperature, the climatic conditions following the cold period, perhaps the amount of moisture in the air during the period, and other factors—all have an influence.

In many peach districts, however, the growers are always apprehensive of injury, even with buds in good condition and all other factors favorable, whenever the temperature reaches 10° to 20° F. below zero, though buds of many varieties often withstand temperatures considerably lower than this when all other conditions are favorable.

Where severe spring frosts occur from year to year during the blossoming period it is not practicable to produce peaches on a commercial basis. Similarly, regions in which protracted warm periods occur from time to time during the winter have usually proved to be uncertain for peaches. The trees become more or less active during the warm periods; the buds start enough to become tender and are injured later even by temperatures which may not be unseasonable for the latitude. For this reason winter and spring injury is sometimes experienced in middle and southern latitudes when peaches in the northern districts escape.

Orchard heaters offer a measure of relief under some conditions in districts subject to unseasonable spring frosts, but such districts are, nevertheless, seriously handicapped in comparison with those where disastrous frosts rarely occur.

PROPAGATION OF PEACH TREES

The average peach grower is not concerned directly with the propagation of trees. It is generally more advantageous for him to purchase them from one who makes the growing of trees his special business than to grow them himself. However, the general features of propagation should be understood by those engaged in peach growing. They are, therefore, briefly outlined in the present connection.

The site selected for a peach nursery should be one that is well drained and where the soil is preferably rather light, though not necessarily sandy. It is important also that the soil should be rather rich, in order to insure as far as possible a satisfactory growth of the trees.

The details of propagating the peach begin with the pits or seeds from which the stocks are grown, and on which the different varieties are budded. The pits are obtained by nurserymen from many different sources. They are handled in different ways, depending quite largely upon climatic conditions, the extent of the business, and other factors.

In the middle latitudes, where probably the largest peach nurseries are located, the pits are generally planted in the fall in rows 3 to 4 feet apart where the trees are to be grown. In the North the pits are sometimes stratified or bedded in the fall in moist sand, where they are under some degree of control, and the planting is delayed until spring. In either case the action of the moisture and freezing temperatures results in the cracking of the "stones." If the pits have been stratified, the kernels are usually sifted from the stones and sand before planting. They are then handled in essentially the same manner as pits that are planted in the fall.

In very mild climates, where there is little action from frosts or freezes, it is probably quite important to prevent the pits from ever becoming dry. If they are not planted as soon as they are removed from the flesh of the fruit, they should be held in such a manner as to prevent the loss of much moisture. Otherwise, a very slow and irregular germination would follow. However, pits that have become dry will frequently germinate fairly well without freezing, provided they are soaked in water for a sufficiently long time before being planted.

The usual method of propagation is by budding,[1] and the seedlings should be large enough to bud by midsummer in their first season's growth. This is done largely during July and August, extending sometimes into September. The buds put in during these months should "take," that is, become attached to the stock, within a comparatively few days if the operation is successful; then they should remain dormant until the following spring. After the buds "take," it is a common practice to "lop over" the tops of the seedling stocks by cutting them nearly off just above the point where the bud was inserted. Subsequently the tops are entirely removed, or the tops may be left until the following spring and then removed without being previously lopped over.

[1] The operations of budding and grafting are fully described in Farmers' Bulletin 1567, Propagation of Trees and Shrubs.

The trees are ready to be planted permanently in the orchard after they have made one season's growth in the nursery. These are known as "1-year-olds," and they comprise the great bulk of the trees that are delivered by nurserymen for fall and spring planting.

A limited amount of budding is done by some nurserymen in June. Buds inserted as early in the season as this are expected to start into growth with but little delay instead of remaining dormant until the next spring, as is the case with the buds that are put in later in the summer. The trees so grown are termed "June buds" and are ready for permanent planting the following fall. While some growers plant this grade of tree with a high degree of success, the majority prefer 1-year-old trees, as already stated. Trees older than one year should not be planted unless in very exceptional instances.

In California the stocks which are budded during the summer are sometimes used the following fall and spring for planting orchards. This practice is commonly referred to as "dormant-bud" planting.

REGIONS FROM WHICH TO OBTAIN TREES

The section of the country from which trees are obtained is unimportant so long as the trees are well grown, healthy, and typical of the desired varieties. The growing of good trees depends upon favorable conditions and proper management in the nursery, and these factors are not peculiar to any particular section.

The inherent qualities of a variety do not change when the trees are grown in different sections of the country. If the variety is hardy, it will continue to be so; if it is susceptible to some disease, it is not made less so by growing the tree during its nursery period in some particular region.

For economy in transportation trees should be purchased as near the place where they are to be planted as practicable. Moreover, trees shipped long distances sometimes suffer injury if they are not properly packed or if they pass through severe extremes of temperature while in transit. Other things being equal, the nearer the nursery the shorter the period during which the trees are out of the ground. On the other hand, differences in the price of trees of the same grade offered by different nurserymen, the desire to secure trees of some special varieties, or some other reason may make it preferable to purchase elsewhere than at the nearest nursery.

TREES FOR PLANTING

As a rule, only thrifty, well-grown, well-rooted, 1-year-old or "June-budded" trees free from injurious insect pests and fungous diseases should be planted. Thrifty, well-grown trees are not necessarily the largest trees which can be found in a nursery. Medium-sized trees are probably fully as desirable for planting as the larger ones, but the smaller grades in some cases may be made up of trees that are stunted and weak from some cause or other. Not infrequently they have poor root systems. The smaller trees can usually be bought at a lower price than the medium-sized and large ones, but they may prove costly in the end, especially if they are lacking in vitality and make a poor growth after being planted.

Peach trees are commonly graded according to their height. In properly grown trees, however, there is a pretty definite relation between the height and the size of the trunk or "caliper" of the tree. The diameter of the stem is sometimes used as the basis for grading nursery stock. The grades, according to height, are designated as "3 to 4 foot," "4 to 5 foot," "5 to 7 foot" trees, etc. Figure 3 shows four trees of each of three different sizes or grades. The relative size and height are apparent. The heaviest grade (C) is composed of larger, more heavily branched trees than the smaller ones; but they are more bulky and heavier to handle, and it is a question whether they will develop into any better trees ultimately than the medium-sized grade. The smallest grade (A) is composed of fairly good trees, but some of them may be lacking in vitality. Sometimes, for the sake of reducing the first cost, a grower buys even smaller trees than the 3 to 4 foot grade, but in most cases this proves to be false economy. A few cents per tree of additional cost means comparatively little in the initial expense of starting an orchard, but it may mean a vast sum later in the life of the orchard in the better development of good, vigorous trees.

Before planting an orchard, every prospective peach grower who has important interests at stake should form an accurate conception of what constitutes good nursery trees in every respect; he should thoroughly famil-

iarize himself with the appearance of the insects and diseases that are likely to be disseminated on nursery stock; and he should give particular attention to the character of the roots and their freedom from such troubles as crown-gall and aphis injury.

TIME OF PLANTING

In general, in northern latitudes, or wherever the winters are rather severe, planting in the spring as early as the soil can be worked to advantage and after the danger of hard freezes is past is to be advised. But in middle and southern latitudes and in regions generally where the winters are mild and where the fall season is favorable for working the soil until late, the planting of trees in the fall is generally successful and by many is preferred to spring planting. The planting should be delayed until thoroughly well and naturally ripened trees can be obtained, but it should be done before the advent of really cold weather. Fall-planted trees should reestablish some root action in their new positions before winter sets in. The danger of winter injury is thus reduced. But in some of the milder portions of the country, where the soil seldom freezes deep and rarely remains frozen for more than a few days at a time, peach trees are commonly planted at almost any time during the winter.

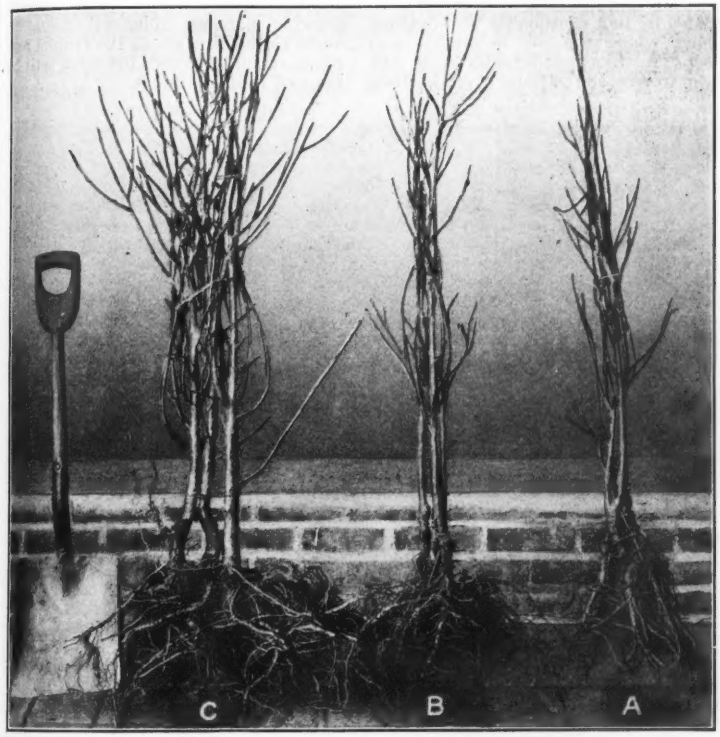

FIG. 3.—Nursery stock, showing different grades or sizes of 1-year-old peach trees: *A*, 3 to 4 foot grade; *B*, 4 to 5 foot grade; *C*, 5 to 7 foot grade

In many parts of California, after the first rains have moistened the soil, usually early in January, the planting may be done to advantage, though some soils may be too cold and uncongenial at that time. In such cases planting is usually deferred until early spring, though there is then some

danger of the trees starting into growth before the soil reaches a suitable condition to be properly handled.

HANDLING THE TREES WHEN RECEIVED FROM THE NURSERY

When received from the nursery the trees should be unpacked immediately. Every possible precaution should be taken to prevent the roots from becoming dry. Unless the trees can be planted immediately, they should be heeled in, in a thoroughly well-drained place, where the soil is mellow and deep. A trench sufficiently wide and deep to receive the roots is made; then the trees are placed in it in the manner shown in Figure 4. In covering, the soil should be worked among the roots of the trees sufficiently to fill all the spaces between them. This will fully exclude the air; otherwise, there is danger of the roots drying unduly. If a large number of trees are to be heeled in at the same place, it will usually be found convenient to place them in closely adjacent rows. When this is done, the trees in one row, for convenience, may be covered with the soil which is removed in opening the next adjacent trench.

Trees that are tied in bundles when received must be separated before being heeled in. If this is not done, it is practically impossible to work the soil among the roots sufficiently well to prevent them from drying to a serious extent.

Sometimes it is necessary to leave the trees heeled in over winter. It is then well to place them in a position which is nearly horizontal, so that the entire portion of the trunks below the branches can be readily covered with soil for the purpose of protection. Such protection is of particular importance in the colder peach-growing districts. The soil should be made rather firm about the trunks and roots, so that harbors for mice will be reduced to a minimum.

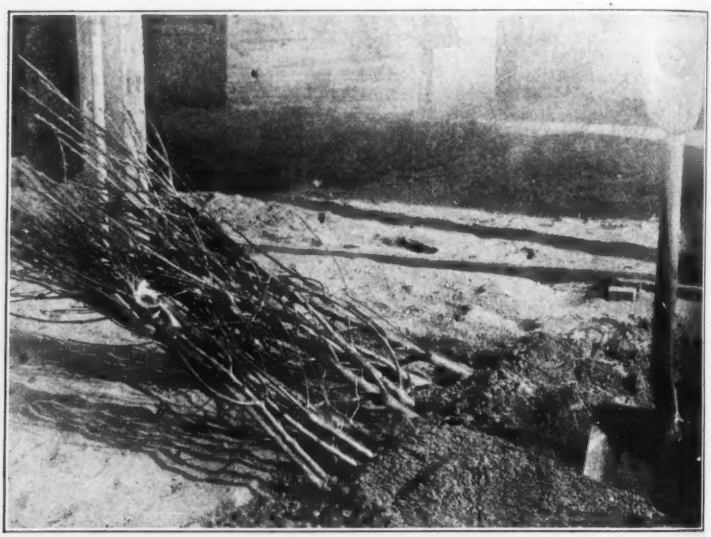

FIG. 4.—Peach trees heeled in. They may be held in this manner in good condition for a long time

PREPARATION OF THE LAND

The ideal preparation of the soil for peach trees consists of deep plowing and thorough pulverizing with the harrow or cultivator, though a certain amount of variation from this ideal may not result disastrously. For example, where newly cleared land is to be devoted to peaches, it is practicable to remove the stumps from a narrow strip along the line of each row of trees, thus making possible a thorough preparation of the strip before the trees are planted and permitting thorough tillage throughout the following season. Each season thereafter the cleared strip should be

widened and the cultivation extended. By the time the trees come into bearing, the stumps should be pretty well cleared from the entire area.

Newly broken sod land can not be as readily fitted for the planting of trees as land that has been plowed long enough for the sod to become well rotted.

PLANTING THE TREES

Peach trees are planted at various distances apart, the topography of the land, the fertility of the soil, the varietal characteristics of the trees, and the preferences and conceptions of individual growers all being factors to be considered. Common planting distances are 18 by 18 feet, 18 by 20 feet, or 20 by 20 feet, requiring, respectively, 134, 121, and 108 trees per acre. Closer planting is sometimes practiced, but it is rarely advisable, and under some conditions 25 by 25 feet probably does not allow the trees more space than they need. The trees are usually planted in squares, as the above distances suggest, but the triangular system or some of its modifications is occasionally used.

Every reasonable care should be observed to plant the trees in straight rows and in perfect alignment in both directions. Trees so placed look better and can be cultivated better and more conveniently than where the rows are crooked and irregular.

Before digging the holes for the trees, some growers plow one or two deep furrows along the line which marks each row, thus greatly reducing the amount of digging that must be done with a spade at the points where the trees are to stand. The holes should be broad enough to admit the roots without bending or crowding them from their natural positions, and deep enough to allow the trees to be planted an inch or two deeper than they were in the nursery.

The use of dynamite in preparing the holes where trees are to be planted has been extensively advocated, but if a soil is well suited to peach growing, it is a question whether dynamiting will improve it materially. If the soil is not adapted to peaches, it is a question whether dynamiting can accomplish any permanent good. Moreover, under some soil conditions positive harm may result.

In some sections a thin stratum of hardpan or other impervious material occurs below the topsoil, while the subsoil beneath the impervious stratum is well suited to peach growing. Undoubtedly the use of dynamite as a means of breaking up such strata is entirely practicable and effective when it is properly applied.

In preparing a tree for planting, all portions of the roots which have been mutilated in digging the trees or injured by any other means should be trimmed off, and long slender roots, if they occur, are usually cut off to correspond with the length of the general root system.

Unless a tree is rather large, the branches should all be removed, leaving only a single unbranched stem, as shown in Figure 5, *A*. This stem should be headed back to correspond with the height at which it is desired to form the head of the tree. The common extremes as to height of top preferred by different growers range from about 12 to 18 inches up to 24 or 30 inches.

But if the larger grades are planted—those, for instance, which are 6 feet or more in height—it is usually safer not to trim to a single unbranched stem. There might, then, not remain enough buds which would give rise to branches properly placed to make a good symmetrical head. It is therefore wise to select from three to five branches that are well distributed about the main stem, from which to develop the head. The limbs thus selected for the foundation of the top should be headed back to mere stubs, as shown in Figure 5, *B*, but on each stub there must be left at least one well-developed bud to insure a starting point for the growth of the branch. With small and medium-sized grades there is little danger that an abundant growth of desirable character will not develop from the main stem.

Danger that the roots may become too dry after they are trimmed and before the trees are planted can be largely eliminated by dipping the roots in a puddle of clay of such consistency that a thin layer of mud will adhere to them when they are dipped into it. Such a coating of mud will afford considerable protection against undue drying out from exposure to sun and wind.

In filling the hole after a tree has been put in position and properly aligned, only finely pulverized soil should be used. Much care should be taken to work the soil in closely about the roots. This may be done to some extent with the fingers. Moving the tree up and down very slightly after the first few shovelfuls of soil have been placed in the hole will also help materially to settle it among the roots.

As the filling progresses, the soil should be firmly tamped about the roots either with the feet or with some sort of a plunger. The soil around the tree should be left about even with the general level of the surrounding surface.

TILLAGE

Tillage refers to the working of the soil after the trees are planted. The objects of tillage have been comprehensively summarized as follows:[2]

(1) Tillage improves the physical condition or structure of the land (*a*) by fining or comminuting the soil and thereby presenting a greater feeding surface to the roots; (*b*) by increasing the depth of the soil and thereby giving a greater foraging and root-hold area to the plant; (*c*) by warming and drying the soil in the spring; (*d*) by reducing the extremes of temperature and moisture; and (*e*) by supplying air to the roots.

(2) Tillage may save moisture (*f*) by increasing the water-holding capacity of the soil; (*g*) by checking evaporation.

(3) Tillage may augment chemical activities (*h*) by aiding in setting free plant food; (*i*) by promoting nitrification; (*j*) by hastening the decomposition of organic matter; (*k*) by extending these agencies (*h*, *i*, and *j*) to greater depths of the soil.

If the tillage is sufficient to maintain the physical condition of the soil and to conserve the soil moisture adequately, the other objects also probably will be realized. An orchard should be tilled, if at all, for the sake of the trees and their product. If without tillage the proper soil conditions exist to an extent which is adequate for the needs of the trees and the production of good crops, then perhaps nothing is to be gained by tillage.

FIG. 5.—Peach trees trimmed ready to plant: *A*, 4 to 5 foot grade; *B*, 5 to 7 foot grade

[2] Bailey, L. H. The Principles of Fruit Growing, p. 76. New York and London, 1915.

With reference to peach orchards, there is comparatively little difference of opinion in regard to tillage. The conviction of the best growers in practically all peach-producing sections is that thorough tillage is essential to the continued successful maintenance of a peach orchard.

To one grower "thorough tillage" may mean plowing the orchard in the spring and harrowing it once or twice later in the season; to another, who has a very high estimate of tillage as a means of preventing the evaporation of moisture from the soil, it may mean going over the orchard with some tillage implement 20 or 25 times during a dry season.

Generally speaking, a peach orchard should be tilled throughout its entire life, beginning with the first season after the trees are planted. If for the sake of economy or for other reasons it is impracticable to work the entire area between the trees, it is usually feasible to confine the tillage for the first year or two to a narrow strip along each row. But the width of the tilled strip should be extended each season, and by the third year the entire surface should receive attention. By that time the roots of the trees extend beyond the spread of the branches, and the entire space between the rows, where the trees have been planted the usual distances apart, is rapidly becoming filled with small rootlets and root hairs through which moisture and plant food in solution are taken up. The root development of peach trees, indicating the position of the roots with regard to tillage and the application of fertilizers, is suggested in Figure 6.

Under normal or standard conditions in most peach-growing districts the advice applies generally, to begin the tillage in the spring as soon as the soil is in suitable condition to work. But in the case of bearing orchards some of the most experienced growers wait until after the fruit has set before they begin, in the belief that earlier tillage may influence adversely the setting of the fruit. The presence of a cover crop, its character, and the needs of the soil with reference thereto are other factors that may influence the date of beginning of tillage. The handling of cover crops is discussed on another page.

If the soil is hard or if there is a cover crop that has made considerable growth, it will be necessary to turn the soil with a plow and follow with a harrow, cultivator, or such other tillage implement as best suits the needs of individual orchards. If the

FIG. 6.—A peach tree about 5 years old growing in "Porter's red clay" soil, Virginia. The spread of the branches was 18 feet. The spread of the roots, as traced, was 36 feet—17 feet on one side and 19 feet on the other

soil is light, plowing in the spring can sometimes be omitted, as some type of cultivator will be found adequate to pulverize thoroughly the soil to a sufficient depth. The surface should be kept as nearly level as possible. For instance, if the soil is plowed toward the trees at one time, it should be turned away from them at a later plowing.

Frequent tillage to maintain a dust mulch 3 or 4 inches deep as a means of conserving soil moisture has long been emphasized. In extensive studies of moisture requirements and conservation carried on by the Office of Dry-Land Agriculture of the Bureau of Plant Industry it has been shown that loss of soil moisture through evaporation from the surface as a result of capillary action, except where the supply is constantly replenished, as by a water table within a few feet of the surface, is very small compared with the loss through the growth of weeds. Besides, every grower is familiar with the difficulties encountered in "wetting up" a dry powder. A dust mulch presents similar difficulties with respect to absorbing the rainfall. The best tillage for conserving soil moisture is that which controls weeds, maintains the soil surface in a fine lumpy or granular condition so that rains are readily absorbed, and sufficiently stimulates the activities in the soil that render plant foods available.

Tillage operations are usually continued until midseason—the last of July or the first of August. By that time the growth of the trees for the season will have been largely made, fruit buds for the next season's crop will have begun to form, the fruit of the midseason varieties will have completed a large proportion of its growth, and the later varieties will finish their development during a period when less moisture is required for the various functions of the tree than earlier in the season. Where cover crops or green-manure crops are desired, they should be sowed, in many cases, by this time.

As the trees become large, some of the extension types of tillage implements are advantageous, as they make possible the working of the soil under the branches without unduly crowding the team into the trees. In one of the large mountain peach orchards in West Virginia, where the broken topography of the land requires strong motive power for efficient work, the outfit shown in Figure 7 has proved especially well adapted. The team of leaders is driven by a "jerk line," the driver riding the near pole horse. The man who rides the harrow not only serves the useful purpose of weighting it down, so that it will cut deep, but he also guides the harrow past the trees by properly adjusting the positions of its two sections. In this way the trees are rarely injured, and yet the harrow can be run very close to them. However, in this particular orchard the use of the harrow is usually preceded by two or three bouts with a light 1-horse plow along each row of trees.

FIG. 7.—An efficient outfit for the tillage of orchards where the topography is much broken and the draft is heavy

The homemade leveler shown in Figure 8 is also a very useful tillage

implement in some orchard districts. Though of special importance in some of the irrigated districts for leveling the irrigation furrows, it is effective in crushing clods and in smoothing the surface of the soil. It consists of two sidepieces of 2-inch plank, 12 or 14 feet long and 6 to 8 inches wide. The crosspieces are 7 or 8 feet wide. The lower edges of the crosspieces where they come in contact with the ground are protected with strips of iron or steel to prevent undue wearing and also to give increased efficiency.

MAINTAINING THE FERTILITY OF THE SOIL

Good tillage and the maintenance of an ample supply of humus or decaying vegetable matter in the soil will do much to keep it in a sufficiently productive condition for peach growing. But continuous tillage of the soil tends to deplete its content of humus unless it is renewed from time to time.

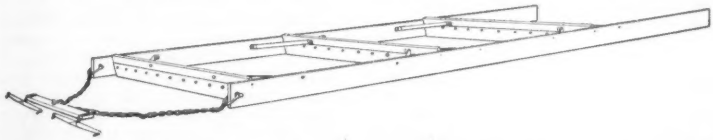

FIG. 8.—A leveler used in some sections for filling irrigation furrows, making the surface of the soil smooth, and pulverizing the clods

USE OF COVER CROPS

Where stable or barnyard manure is abundant there is probably no more satisfactory way of supplying humus to the soil than by a liberal use of it. Manure is seldom obtainable, however, in sufficient quantity to meet any far-reaching needs. In its absence the use of cover or green-manure crops is to be advised.

The ways in which a cover crop may contribute to the welfare of the orchard have been enumerated as follows:[3]

(1) It protects the land and directly improves its physical condition; prevents hard soils from cementing or puddling; holds the rains and snows until they have time to soak away into the land; dries out the soil in spring, making early tillage possible; prevents washing in winter; and sometimes serves as a protection from frost.

(2) It improves the chemical condition of the soil; catches and holds some of the leaching nitrates; adds humus to the soil; renders plant foods available; appropriates nitrogen, if it is a leguminous crop.

The plants commonly used for cover-crop purposes fall into two groups—leguminous (or nitrogen-gathering) and nonleguminous. The former group comprises red clover, crimson clover, bur clover, field peas, vetch, cowpeas, and others; the nonleguminous group consists of rye, oats, buckwheat, millet, rape, turnips, and various others. Sometimes the growth of weeds or other more or less spontaneous growth is encouraged after the seasonal cultivation is ended, as a means of obtaining a cheap supply of vegetable matter for the soil.

Red clover is more commonly used in apple orchards than in peach orchards, and especially when it is intended to omit tillage for a season. Vetch is apparently being used more and more as an orchard cover crop in the northern fruit districts. Crimson clover is especially satisfactory in some of the light soils in New Jersey and Delaware in seasons when there is a good supply of moisture in the soil at the time of seeding. Cowpeas are very widely used for this purpose in middle and southern latitudes.

Probably rye is the most widely used nonleguminous plant. It can be sowed late in the season, and it lives over winter and starts into growth early the next spring. All of these points are important considerations in many instances. But oats in combination with vetch have been especially satisfactory in some cases, and German millet has been shown to be almost an ideal nonleguminous cover crop under some of the conditions that prevail in Nebraska.[4]

In starting the cover crop, the usual practice is to sow the seed when the orchard is given its last cultivation for the season, usually in July or early in August, though the exact time is regulated by conditions. Sometimes cowpeas are planted in drills in June and tillage continued with a small cultivator. Where rye is used, it is

[3] Bailey, L. H. Op. cit., pp. 113–114.

[4] Emerson, R. A. Cover crops for young orchards. Nebr. Agr. Exp. Sta. Bul. 92, 93 p., 12 fig., 1906.

commonly put in toward the close of the growing season.[5]

When a cover crop is used in a peach orchard it should be plowed under as early in the spring as practicable, unless the growth that is on the ground can be worked into the soil effectively and more conveniently by the use of a disk or cutaway harrow. However, if there is an abundance of moisture in the soil, the turning under of the cover crop is delayed in many cases until after it has made considerable growth in the spring, in order to obtain as large a quantity of vegetable matter to be worked into the soil as is possible.

The use of cover crops is sometimes limited in particular seasons by lack of moisture. If there is a protracted drought at the time the seed should be put in and the trees are suffering therefrom, it might do more harm than good to make a further demand upon the moisture in the soil by sowing a cover crop, even though the soil may be known to lack humus.

In certain districts of generally low precipitation in which peaches are being grown successfully, continuous clean tillage, with the return of practically no vegetable matter to the soil, is bringing the ground into poor physical condition. Stable manure as a source of humus is not to be had in sufficient quantity to be of any real value, and the limited moisture supply is not sufficient to maintain the peach trees and grow a cover crop at the same time. This situation as it exists in some districts presents serious problems. The growers are beginning to realize its import.

Likewise in some irrigated districts where the water supply is limited, the need of a cover crop may have to be disregarded, either habitually or in seasons of unusual water shortage, because there is not enough moisture to meet the demands of both the trees and the cover crop.

Aside from maintaining the fertility of the soil, cover crops may have important functions in other respects. Where the soil is subject to washing, a cover crop which survives the winter will often prevent or materially lessen the washing that would otherwise occur.

If good tillage and the wise use of cover crops fail to produce the best results in a peach orchard that is well situated, the use of commercial fertilizers may then logically receive consideration as a last resort.

USE OF FERTILIZERS

There is no "best" fertilizer for peaches, and no particular fertilizer can be recommended. A fertilizer which is economical to use and which gives maximum results in a particular orchard might be without appreciable effect in another orchard.

In maintaining soils in a highly productive condition it is important to learn what factors are limiting the performance of the orchard. The limiting factor may be an insufficient supply of some kind of plant food, improper physical condition of the soil due to a lack of humus or poor drainage, or it may be something else. The real problem is to determine what the trouble is and then apply the proper remedy, if it is known.

Fertilizers are often largely without appreciable effect if they are applied to soils that are in poor physical condition, as when they are greatly lacking in humus. For this reason attention should be given to the use of fertilizers only after the possibilities of tillage and the maintenance of the soil in good physical condition have been exhausted.

It follows that a complete fertilizer may give excellent results. But if there is an insufficient supply of only one plant food, then it may be assumed that the response from the fertilizer is due to the presence in it of that plant food of which there was an insufficient supply in the soil and that the other plant foods in the fertilizer were without any real value to the crop or trees. Obviously under such conditions a complete fertilizer would not be economical.

The wiser plan is to carry on a few experiments with a view to determining local needs. A representative portion of the orchard may be selected. To a few trees—perhaps 5 or 6—nitrogen may be applied; to other trees, potash; and to still others, phosphoric acid. Different combinations of these plant foods, including one which has all of them, thus making a complete fertilizer, may be applied to other groups of trees.

[5] The amount of seed of the various cover crops commonly sown per acre is as follows: Red clover, 10 to 15 pounds; crimson clover, 12 to 16 pounds; bur clover, 20 pounds; field peas, 1½ to 2 bushels; vetch, 1 bushel (60 pounds); cowpeas, 1 to 2 bushels; rye, 1½ to 2 bushels; oats, 2 to 2½ bushels; buckwheat, one-half to 1 bushel; millet, ½ to 1½ bushels; rape, 3 pounds; turnips, 3 pounds.

If a detailed record is made of the different applications and each group of trees treated the same way each season for several successive years, gradually the results of the different fertilizer treatments will become apparent in the behavior of the trees, their growth and vigor, the productiveness and regularity of the crops, the quality of the fruit, and in other ways. From such results the grower who has carefully studied the conditions should be able to decide upon a rational basis for the use of fertilizers in his own orchard.

IRRIGATION

Most of the peaches produced in the Intermountain States and west of the Rocky Mountains are grown under irrigation. It is not feasible, however, to discuss the details of irrigation in this bulletin. They are discussed in Farmers' Bulletin 1518, entitled "Orchard Irrigation."

PRUNING

As a general proposition the most successful fruit growers habitually prune their trees, and in doing it they usually follow more or less closely some plan or system, even though they may have no clear-cut conception of just what their plan involves.

The principal objects sought in pruning may be summarized as follows:

(1) To modify the vigor of the tree.
(2) To keep the tree shapely and within bounds.
(3) To make the tree more stocky.
(4) To open the tree top to admit air and sunshine.
(5) To reduce the struggle for existence in the tree top.
(6) To remove dead or interfering branches.
(7) To renew the vigor of the tree.
(8) To aid in stimulating the development of fruit buds.
(9) To secure good distribution of fruit buds throughout the tree.
(10) To thin the fruit.
(11) To induce uniformity in the ripening of the fruit.
(12) To make thorough spraying possible.
(13) To facilitate the harvesting of the fruit.

The pruning which a tree receives during the first two or three years after it is planted has much to do with its future. Mistakes in forming the head or the results of neglect during the early years in the life of a tree are practically irreparable. On the other hand, if the tree is well formed and properly pruned during its first years, the foundation for a good tree is established; subsequent errors in pruning, if they occur, may admit of correction without permanent harm to the tree.

In general, the proper time to prune peach trees is during the dormant period, preferably in late winter or early spring, just before growth starts, except in regions where bleeding from wounds is likely to occur. In such regions it should probably be done in early winter. But conditions and the object of the pruning must be considered in each case. If the pruning operations are very extensive, it may be necessary to prune throughout the winter whenever the weather is suitable for men to work in the orchard. If the fruit buds are endangered during the winter by adverse temperatures, it may be advisable to delay pruning as much as economic conditions permit until settled spring weather arrives. This is especially advisable if heavy heading back of the previous season's growth is desirable for the sake of the tree, since if a large proportion of the fruit buds are killed it may be best for the prospective crop not to cut back heavily.

A limited amount of summer pruning can usually be done to advantage. The trees should be observed constantly throughout the season of active growth. Whenever a branch is seen to be so placed that it obviously will need to be removed at the annual pruning for the shaping up of the tree, it is well to take it off at once. In this way the annual pruning can be reduced to a minimum and the removal of large limbs will rarely be necessary.

Then, too, it frequently happens that a single branch in the top of a tree will grow considerably faster than any of the others, making the tree unsymmetrical if the growth of the branch is not checked. A slight heading in as soon as such a tendency is apparent will usually keep the top well balanced.

The pruning of a peach tree at the time of planting it has already been discussed. A tree well along in its first season's growth is shown in Figure 9. It will be observed that the top is formed of four main branches. This tree shows evidence of having received attention during the earlier part of the season. Only those branches which were of importance in forming the top have been allowed to develop. The exact number of branches which may be used in forming the head is not an arbitrary mat-

ter. From three to five branches are permissible if they are well placed and properly distributed on the main stem of the tree. The branches that form the head of the tree shown in Figure 9 start from points on the trunk which are rather too close together. If there was more space between the branches where they join the trunk there would be less danger of the limbs breaking down in later years from the weight of heavy loads of fruit.

FIG. 9.—A peach tree of the Muir variety during its first season's growth. The cross lines shown in the figure are intended to suggest suitable points at which to cut the branches when the pruning is done later on. (Photographed in California, Aug. 27, 1913)

During the dormant period between the first and second year the first year's growth, provided it has been thrifty and vigorous, should be headed back rather heavily; perhaps one-half or two-thirds of the growth should be removed. The cross lines shown in Figure 9 suggest suitable points at which to cut the branches when the pruning is done later on. However, this needs to be considered with several things in view: The symmetry of the tree, its strength and vigor, and its future development. In order to provide for an open, well-formed head in later years, it may be necessary to thin out some of the smaller, secondary branches. In doing this, however, provision must be made for a uniform distribution of limbs so spaced that the open top desired will be insured and yet the main limbs still carry an ample number of secondary branches.

Pruning the second and third years does not differ in principle from that which follows the first season's growth. At each pruning the previous season's growth is headed back, though perhaps not quite as much as at the first pruning. This, however, will depend upon the character of the growth and the condition of the tree. If it is stocky and strong less heavy heading back will be required to serve the end in view, but long, slender, spindling growth should be shortened back as severely after the second or third season as at the earlier pruning.

At each subsequent pruning the secondary branches require the same attention as at the first pruning. The points which require particular attention are thinning out enough to keep the top open and shortening in heavily in order to produce a new growth of bearing wood evenly distributed throughout the top of the tree and on the interior surfaces of the main limbs.

The effects of not heading in are shown in Figure 10. The trees here shown are making their second or third season's growth. They were not well headed in at first, and no heading back has been done since they were planted. Besides, the soil is lumpy and in poor tilth, and the trees are making a weak, slender growth. Had they been well headed back, the growth would have been much more stocky, even though the trees were small, and they could be in much better condition to sustain the weight of a crop of fruit than they can pos-

sibly be under the system of management that has been followed.

The tree shown in Figure 11 has been pruned more or less, but it exhibits serious defects. It has not been well headed back, the top has not been properly opened, and the smaller, secondary growth has been entirely pruned from a considerable portion of each of the main limbs instead of being utilized to develop fruit-bearing branches in the center, where its weight can best be supported without breaking the tree. With the bearing wood largely developed toward the outer extremities of the branches and the size of the branches disproportionately small for their length, even a small crop of fruit would be likely to break the tree to pieces very badly. This tree may well be contrasted with the trees shown in figures 12 and 13, which have been pruned with a view to developing the characteristics referred to. The limbs are stocky and well proportioned for sustaining heavy crops of fruit. The interior of the trees is well filled with bearing wood, and at the same time the tops are sufficiently open to admit a full quota of sunshine to practically all the fruit.

FIG. 10.—Peach trees about 3 years old that have not been headed in. The limbs are slender and will probably break badly with the weight of the first good crop of fruit

FIG. 11.—A peach tree that has been badly pruned. The bearing wood is near the extremities of the limbs. The weight of even a small crop of fruit would be likely to break the limbs to a serious extent

By the time peach trees are 3 or 4 years old they should be bearing good crops of fruit. After this they will make a smaller annual growth under usual conditions than during the earlier years. Less heading in is therefore required. In some seasons it may not be necessary to cut back the terminal growth, though to do so will tend, as a rule, to develop the smaller secondary and side branches. This is desirable, for reasons already mentioned. Again, the extent of the heading back will be governed in some seasons by the abundance and condition of the fruit buds. If there has been winter injury or if the buds failed

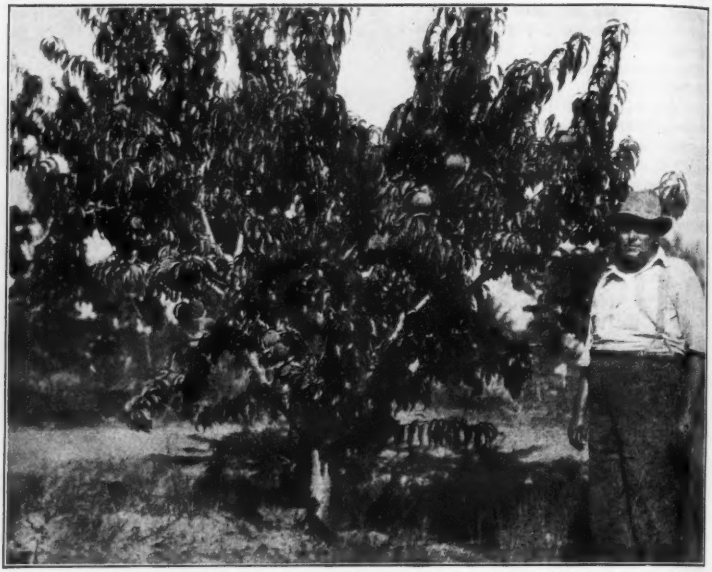

FIG. 12.—A Levy peach tree 8 years old pruned with a view to developing strong, stocky branches and an open top. (Photographed in California, Aug. 28, 1913)

FIG. 13.—Phillips peach trees 10 years old. These trees have been systematically headed back, and strong, stocky limbs have developed. It is necessary, however, to prop them when very heavily loaded with fruit. (Photographed in California, Aug. 27, 1913)

to form well the previous season, little or no reduction of the previous season's growth will be needed. On the other hand, if the trees made a strong growth, an abundant set of fruit buds developed, and they have suffered no injury, a correspondingly heavy cutting back of the previous season's growth may be advisable in order to thin the fruit as much as is possible by that means.

Peaches are always borne on wood that grew the previous season. Therefore after a peach tree reaches bearing age it is essential so to manage it as to induce a fairly liberal growth each season.

As a general proposition, very heavy pruning will induce a correspondingly large amount of new wood growth. It follows that the weaker growing varieties should be pruned more heavily, relatively, than the very strong-growing sorts.

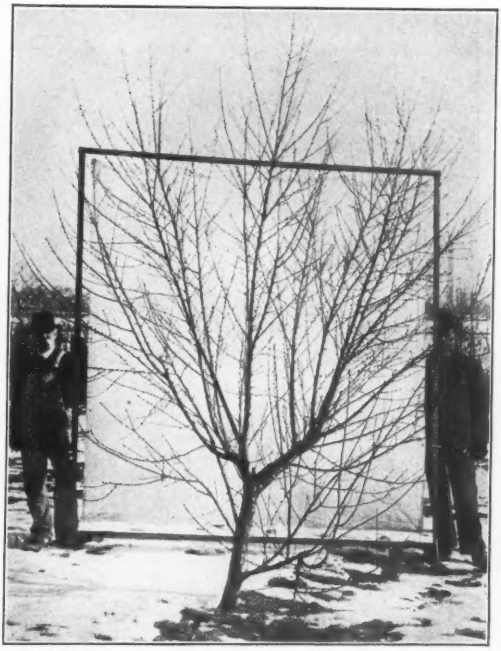

FIG. 14.—A peach tree about 8 years old, before pruning

Some of the details of pruning mature peach trees are suggested in Figures 14 and 15, which show a tree 8 years old before and after it received the annual pruning to make it shapely, remove superfluous wood, and provide for the development of new growth. While the tree illustrated is far from being ideal, as it had not been well handled in previous years, it shows certain important features. The heading back of the main limbs will tend to prevent them from becoming "leggy," and it will induce a good, strong growth of new fruit-bearing wood well within the center of the tree. It may require some thinning out at the next annual pruning to prevent the top from becoming too dense. Probably more wood of the previous season's growth should have been left than is shown in Figure 15, as there ap-

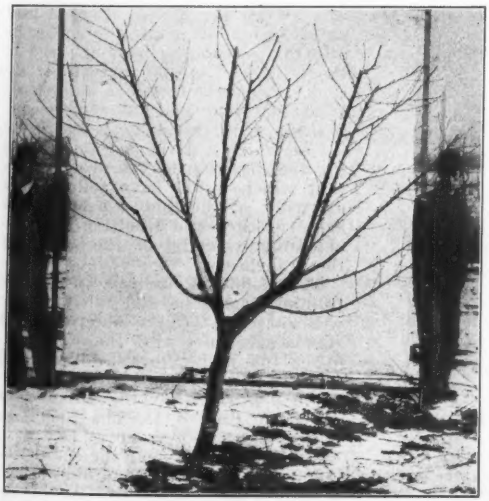

FIG. 15.—The same tree shown in Figure 14 after being pruned

FIG. 16.—Elberta peach trees 14 years old which have been pruned with a view to producing open, spreading tops. The branches of the two trees together in the foreground have an expanse of about 55 feet. (Photographed in Colorado, Aug. 23, 1910)

pears to be only a small amount of surface on which fruit can be produced the following season; but apparently the tree has been put in fairly good condition with regard to its later usefulness.

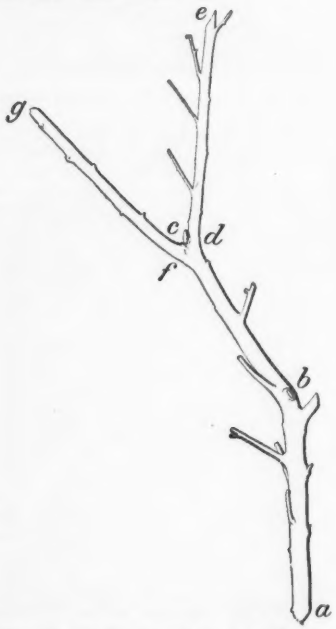

FIG. 17.—A branch which suggests the possibilities of influencing the habit of growth by the position of the bud left at the end when the branch is cut back

The growing of an open-headed tree is not merely a matter of keeping the top well thinned out. The position of the branches can be controlled and directed to a marked extent by the manner in which the pruning is done. Figure 16 shows two Elberta trees which have a rather remarkable spread of limb. Systematic pruning and heading in were practiced in the earlier years of these trees. The spreading habit has been augmented by cutting the branches to outside buds when they were headed back. The significance of this is more clearly shown in Figure 17, which was drawn from life. When the branch was cut back at *b*, during the winter following its growth, the bud nearest the end of the stub was on the outside of the limb. When the branch *b c* developed from that bud the following season, it made a decided angle with the one *a b* on which it developed, thus changing the direction of the growth from that which would have followed the extension of the limb *a b* had it not been cut back and resulting in a considerable widening of the spread of the branches.

The following season, when the pruning was done and the limb *b c* was cut off at *c*, the outermost bud was nearly on top of the stub at *d*. When this bud gave rise to a branch *d e*, the limb *b c* was continued thereby in approximately the direction of the older limb *a b*. The limb *f g*, which developed from a bud at *f*, which was not as near the end of the stub as was the bud at *d*, did not materially change the direction of the branch *b c*. Had the bud at *d* been

on the outside, the spread of the branch would have been still more widened, as was the case when the branch *b c* grew from *b*, the latter being an outside bud. If it is desired to correct the habit of growth in the case of a tree that is too spreading to be desirable, cutting back the limbs to inside buds will tend to accomplish the end in view.

Heading in a tree from year to year as suggested, and pruning with a view to producing an open, spreading, low top results not only in the development of strong, stocky limbs well able to sustain heavy loads of fruit, but it brings a large proportion of the top near the ground, where much of the fruit can be harvested without the use of stepladders.

The man who prunes a fruit tree during its first years must have a pretty clear conception of what the tree is to look like when it reaches maturity, and he needs to know from the beginning what is necessary each time it is pruned in order to develop the tree which forms his mental vision. A well-formed plan, based on a knowledge of the underlying principles of pruning, is essential if the operation is to be anything more than a haphazard removal of branches that appear to be in the way.

Figure 18 shows a type of stool that is used in one of the Allegheny Mountain peach orchards both in pruning the trees and in harvesting the fruit. The legs spread enough to make the stool stand firm and to give the workman a sense of security when standing on it. When intended for use in an orchard that is located on a very steep slope, the two legs on one side of the stool are made somewhat shorter than those on the other side.

A sled similar to the one shown in Figure 19 is very convenient under some conditions for removing the brush from an orchard after it has been pruned. Another way of disposing of the brush is shown in Figure 20. This device consists of a frame made of piping and lined with sheet iron. It is mounted on iron or steel wheels. The brush is thrown into it and burned as it is drawn through the orchard.

FIG. 18.—Pruning Salwey peach trees in an Allegheny Mountain orchard in West Virginia

RENEWAL OF THE TOPS

If a peach tree is neglected as to pruning during its early years and the branches are allowed to become long and slender; if, as it attains considerable age, the bearing wood, in spite of the pruning which it has received, has grown out of convenient reach in harvesting, or if for other reasons it

FIG. 19.—A sled used for hauling brush from an orchard. (Photographed in West Virginia)

becomes desirable to renew the top of a tree, it is usually entirely practicable to do so, provided the trunk and main limbs are sound and healthy. Renewal of the top will often result in prolonging the usefulness of a peach tree for several years. This operation is exemplified by several of the accompanying illustrations. Figure 21 shows an 8-year-old peach tree which has become rather "leggy." The annual growth for several seasons has nearly all been made near the extremities of the limbs. Very little new wood has grown in the interior of the tree.

Figure 22 shows the same tree after being severely headed in, or "deheaded," with a view to developing a new top. The small branches which remain on the stubs of the old limbs are an advantage, as they will start into growth more readily than the latent buds from which the new top would have to develop in the absence of small branches of recent growth.

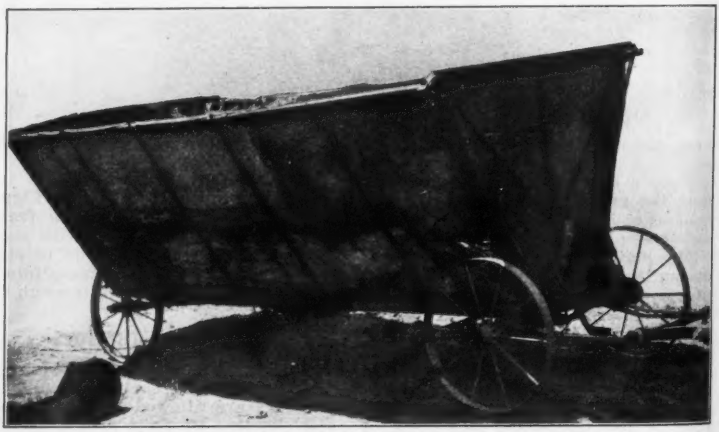

FIG. 20.—A wagonlike device in which the brush pruned from trees is burned as it is drawn through the orchard. (Photographed in California)

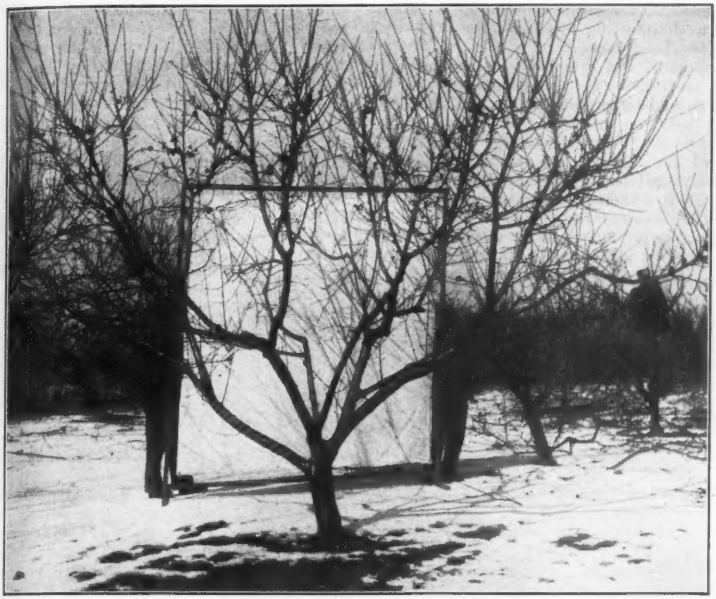

FIG. 21.—A peach tree 8 years old in which the new growth, i. e., the fruit-bearing wood, has been made largely at points far remote from the main limbs

Figure 23 is a third view of the tree shown in Figures 21 and 22, well advanced in its second season's growth after being deheaded. This particular tree was somewhat lacking in vigor; and its growth, following the treatment for the renewal of the top, was not as satisfactory as it otherwise would have been. Figure 24 shows a 7-year-old Elberta tree which was thrifty when it was headed back to about the extent indicated in Figure 22. The illustration shows this tree near the end of its first season's growth after being deheaded. It should bear a crop of fruit the next season.

If a tree which lacks vigor is treated in this way the result shown in Figure 25 may occur. Some of the stubs had no buds strong enough to develop; hence the top was only partially renewed. If the tops are cut back to wood that is not more than 3 or 4 years old, a stronger, more symmetrical growth may be expected than where the stubs left in deheading are older. Occasionally, where the trunk remains sound and retains its vigor, the tops are renewed two or three

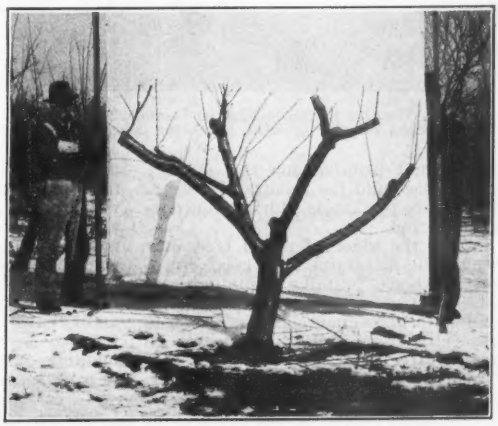

FIG. 22.—The tree shown in Figure 21 after being deheaded

times. As a rule, however, it is impracticable to dehead for renewal more than once.

Sometimes, when for any reason it is desirable to renew the top of a comparatively young tree, the heading in may be made much more severe than that suggested by Figures 22 and 25. This is shown in Figure 26, where all the branches have been cut back to the trunk of the tree.

The season for deheading to renew the top is the same as that for doing the annual pruning for the shaping of the trees and the removal of superfluous wood—that is, during the dormant period.

FIG. 23.—The tree shown in Figures 21 and 22 during its second season's growth after being deheaded

When the vigor of peach trees has been well maintained by good cultural methods, suitable pruning, and wise management in every respect, their life of commercial usefulness is generally from about 8 to nearly 20 years after the full-bearing age is reached. It varies widely, however, under different conditions. In some sections it is rarely profitable to continue them after they reach the age of 12 to 15 years; in others they are expected to last until they are from 15 to 18 or 20 years old, while occasionally an orchard 20 to 25 years old is found which is still of commercial value. Instances of individual trees remaining productive until a much greater age are not uncommon, but they seldom, if ever, represent orchard conditions.

CHANGING THE TOP BY BUDDING AND GRAFTING

Sometimes it is desirable to change the top of a peach tree from one variety to another. A grower may find after his orchard begins to bear that he has a larger number of trees of some variety than he wants; a block of trees may prove to be some other variety than the one ordered; or, for some other reasons, a variety is not well adapted to the needs of the owner. In such cases he may top-work the tree either by budding or by grafting it to a desirable variety.[6]

The ordinary method of shield budding is most commonly used for this purpose. If the tree to be top-worked is not more than two or three years old, it is usually practicable to insert the buds directly into the main limbs well down toward the point where they leave the trunk. This is illustrated in Figure 27, which shows a Triumph peach tree that was budded to the Carman variety when it was 3 years old, after its crop of fruit had been removed. The points where the buds were inserted are shown in the figure.

If the tree to be top-budded has reached the age when the bark on the main limbs has become too thick and firm to be manipulated readily for budding, it is necessary first to head it back somewhat, as when the top is

[6] The operations of budding and grafting are fully described in Farmers' Bulletin 157, entitled "The Propagation of Plants."

to be replaced with new growth of the same variety, and later insert the buds on the new branches that develop after the tree has been deheaded. When this course is followed, the buds should be inserted in the new growth as near the trunk as is practicable, in order to have as large a portion of the top as possible of the new variety. This is also desirable on account of the subsequent management of the tree.

Top-working is sometimes done by grafting instead of budding, the ordinary cleft graft being generally used. However, budding is to be preferred, especially as the wounds made in grafting do not heal readily in the case of the peach, though when properly done the union of stock and scion is generally strong enough to make a fairly serviceable tree. But troubles resulting from difficulties in the healing of the wounds are likely to occur.

Fig. 24.—An Elberta peach tree 7 years old that was deheaded about as indicated in Figure 22, showing its first season's growth after being cut back. It should bear a crop of fruit the following season. (Photographed Aug. 15, 1911)

THINNING THE FRUIT

Most varieties of peaches, as well as other fruits, for that matter, under favorable conditions often set much more fruit than the tree can possibly develop to a good degree of perfection for commercial purposes. The natural tendency of the tree is to perpetuate its kind. To this end, left to itself, it develops the largest possible number of seeds, with each seed possessing the possibility of a new tree.

The grower's aim, however, is for the tree to produce the largest possible amount of fruit that can attain the highest commercial standard. The effort of the tree and the object desired by the grower tend to impose incompatible requirements. The development of a great number of seeds is a tree-exhausting process. This is opposed to the development of large fruits. To meet his ends in this respect, the grower has recourse to thinning the fruit.

Perhaps no operation in the production of peaches requires keener judgment than thinning the fruit. No fixed rules for it can be given. A common practice, very generally applicable, is to thin so that the fruits will not be nearer together than 4 to 6 inches. But the strength of the tree, the fertility of the soil, and especially the soil moisture, together with the size of the crop (or, in other words,

the number of fruits allowed to develop on the tree), govern very largely the size and perfection of the individual fruits.

Obviously, a vigorous tree growing under favorable conditions as to moisture, plant food, etc., can develop a larger number of fruits to good size than can a weak tree, or even the same tree when there is a marked deficiency either in the supply of moisture or of plant food.

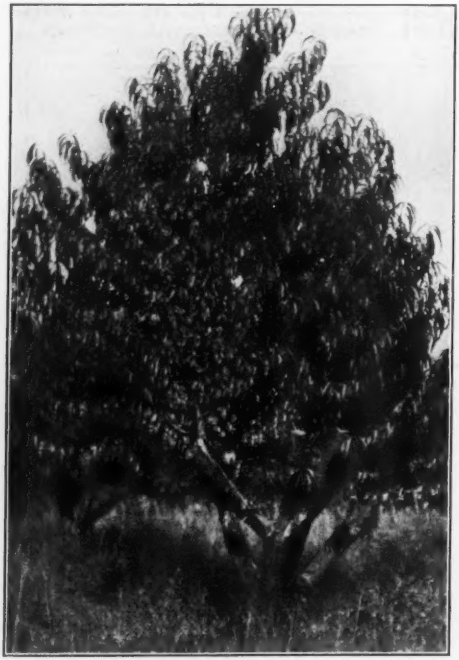

FIG. 25.—A peach tree that has been deheaded, but which did not develop a symmetrical top because some of the stubs had no buds strong enough to develop branches

The skill of the grower is shown in his ability to adjust the size of the crop on his trees to the conditions of the season. He can reduce the number of fruits on the trees if the season becomes very dry as it progresses. Thus the grower should aim to control the size of the individual fruits by thinning and by tillage and pruning.

While thinning may cost a relatively large amount per tree, actually more high-grade fruit is produced, as a rule, on a tree which bears only a moderate crop than on one which is heavily overloaded, and the average fruit on the tree with a moderate crop is of better grade than the best fruit on an overloaded tree.

The thinning should be done after the "June drop"—which usually occurs from a month to six weeks after the blossoming period, when the imperfectly fertilized and other weakly developed fruits drop off—and before the pits begin to harden. After the "June drop" is over there is very little dropping of the peaches. Hence, practically all the fruit which remains then will be on the trees at harvest time. It will have to be picked then, anyway. It probably costs considerably less to pick a portion of the crop in June or July and drop the fruit on the ground than to pick it later and put it in a basket, where much of it will have to be handled over several times in grading and packing and then finally large quantities discarded as culls because the fruits are so small. Moreover, the fruit on an overloaded tree will sometimes ripen less uniformly than on a tree that has a moderate crop.

As the development of its pits is an exhaustive process, the limiting of the number of fruits tends to conserve the vitality of the tree. A large portion of the flesh of the peach is water; hence, if the soil is well supplied with moisture the development of the edible portion of the fruit makes a relatively light demand on the strength of the tree.

CONTROL OF INSECT PESTS AND FUNGOUS DISEASES

After a grower has pruned intelligently, tilled and fertilized his orchard well, and irrigated it if required, the orchard may be short lived and the crops financial failures if he neglects to give proper attention to the control of insects and diseases, a considerable number of which are to be found pretty nearly everywhere in the sections where peaches are grown.

Emergency matters should be referred to the agricultural experiment station of the grower's State without delay.

Inquiries relating to any phase of fruit growing may also be referred at any time to the United States De-

partment of Agriculture, where, without cost, through the department's experts, as full information relative to the problems as can be given may be obtained.[7]

GROWING CROPS BETWEEN THE TREES

Frequently some annual crop is grown between the trees during the first two or three seasons to help meet the cost of maintenance during the unproductive age of the orchard. This practice is seldom any advantage to the trees in comparison with thorough tillage by itself, but if the crops are wisely selected and properly managed they are not likely to do any serious harm.

The crop ought to be one which needs essentially the same tillage that the peach tree should have, so as not to interfere seriously with that operation. But the grower should realize that he is, in effect, following a system of double cropping and that because of the crop between the trees he may need to give more attention to maintaining the fertility of the soil than he would for the peaches alone.

After the trees reach bearing age they should not be made to compete with another crop. Even if the plant food in the soil is sufficient to produce successfully two crops at the same time, the peach trees usually will need all the available soil moisture, except, of course, in sections where irrigation is practiced and the supply of water is adequate for all purposes. Besides, a crop between the trees would be likely to interfere with the spraying of the trees (if the operation should be necessary), with the harvesting of the fruit, and in other ways.

Muskmelons, beans, peas, cabbages, tomatoes, and other truck crops are extensively grown between peach trees in different sections. Potatoes are sometimes used, but they are suitable only when the crop can be so managed that the digging of the potatoes will not amount to a late cultivation, which may be attended with undesirable results. Corn, also, is frequently used, but as very often managed it is objectionable, because it shades the trees excessively. Whenever corn is used, an open strip of considerable width should be left along the rows, so that the trees will be fully exposed to the sunlight throughout the season. If a very tall, strong-growing variety of corn is used, a wider strip should be left unplanted than where a dwarf variety is selected.

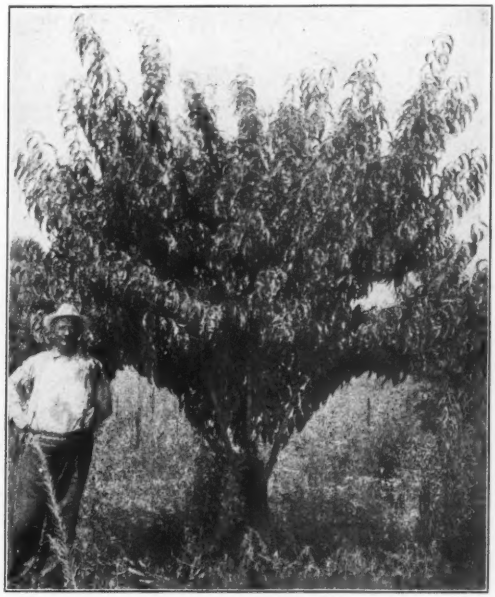

FIG. 26.—A peach tree that shows the possibility of developing an entirely new top when the limbs are cut back to the trunk. This is not likely to be successful except on comparatively young trees

Peach trees are sometimes used for planting between trees, especially where apples comprise the permanent crop. This practice is highly recommended by some and emphatically con-

[7] Farmers' Bulletins of value to peach growers in combating insects and diseases include: No. 1246, The Peach Borer—How to Prevent or Lessen Its Ravages; the Paradichlorobenzene Treatment; No. 1527, Peach Brown Rot and Scab; No. 1557, Insects Attacking the Peach in the South and How to Control Them.

demned by other fruit growers of wide experience. It is probably objectionable in that for a period of years both bearing and nonbearing trees occupy the same area, and it is sometimes desirable to treat a fruiting tree very differently from one that is not fruiting, for the best results with each. On the other hand, where a site is particularly favorable for both fruits, a compromise treatment can often be effected which yields fairly satisfactory results with both kinds of trees.

FIG. 27.—A 3-year-old Triumph peach tree top-budded with the Carman variety after harvesting the season's crop of fruit. This shows the tree about one year after the Carman buds were inserted at *a*, *b*, *c*, and *d*

ORCHARD MANAGEMENT AND WINTER INJURY

In nearly all of the experiment-station bulletins on peach culture, in current horticultural literature, and in the standard works in which peach growing is discussed in detail, emphasis is habitually placed upon the necessity of so managing the orchard that the trees will cease growing and the wood become fully mature before the advent of cold weather. Otherwise, serious winter injury is anticipated. To accomplish this end it is generally advised to cease tillage in July or early August, to withhold fertilizers rich in nitrogen, and to avoid excessively fertile soil in selecting sites for peach orchards.

Undoubtedly such advice is perfectly sound and applicable to a large proportion of the peach-growing districts, but there appear to be some rather marked exceptions that are applicable in important peach-growing sections, to which the reader's attention may well be directed.

These exceptions to the general practice have been brought to light largely through investigations carried on by the Missouri Agricultural Experiment Station.[8] They consist primarily in so managing the orchard as to maintain the trees in active growth until rather late in the season. This may be accomplished by continuing the tillage later than is ordinarily advised, by using a nitrogenous fertilizer, or by heavy pruning, which results in a vigorous growth of new wood. Any condition that seriously reduces the vitality of the tree tends to make the tree, especially the fruit buds, susceptible to injury by winter temperatures. The production of an excessive crop of fruit is a common cause of depleted vitality. The conclusions of the Missouri experiment station tentatively summarized are as follows:[9]

> Where nitrogen was applied to peach trees a good crop was produced and harvested. On plats receiving no fertilizer there was practically no crop. There was likewise a failure of peaches in the surrounding region where no fertilizer was applied. The cold winter of 1911–12 was disastrous to peach trees in Missouri. Injury to peach trees caused by the cold so weak-

[8] Missouri Agricultural Experiment Station Bulletin 74, entitled "The Winter-Killing of Peach Buds as Influenced by Previous Treatment."

Missouri Agricultural Experiment Station Circular of Information 31, entitled "Hardiness of Peach Buds, Blossoms, and Young Fruit as Influenced by the Care of the Orchard," being a reprint from the Annual Report of the Missouri State Board of Horticulture, 1908.

Missouri Agricultural Experiment Station Bulletin 111, Report of the Director for the Year Ending June 30, 1912.

[9] Missouri Agricultural Experiment Station Bulletin 111, Report of the Director for the Year Ending June 30, 1912, pp. 247–248.

ened their vitality that disease like the bacterial shot-hole leaf disease was common. On the plats fertilized with nitrogen there was little bacterial disease. On adjacent untertilized plats the injury from this cause was very great. The trees in the plats fertilized with nitrogen also recovered from winter injury much more successfully and quickly than unfertilized trees in the same locality.

The application of phosphorus and potassium either singly or in combination did not result in increased yields. The results of the investigations on fertilizers for peaches seem to indicate clearly that a nitrogenous fertilizer or a method of cultivation and management which favors a vigorous tree growth when combined with pruning, spraying, and thinning fruit on overloaded trees will increase the crop. The above treatment tends to make them carry their fruit buds through winter and frosts of spring much more safely than where an average or weak growth only is secured. Our results seem to disprove the theory that trees must make their main growth early in the season and then be checked or retarded in their growth in August or September in order to ripen their wood before going into winter. In some experiments at this station where the trees have been encouraged to grow vigorously right up until some of the green leaves froze on the trees, either by the use of fertilizer or by severely pruning back the winter before or by thinning the fruit, they have uniformly carried their fruit buds through the winter much more safely than with trees that shed their leaves and ripened their wood early.

A very careful correlation of these results with the conditions which are generally considered essential in the growth of peach trees in the northern districts is necessary in order to understand their significance. There is no real conflict or lack of harmony in the methods advised for the different regions, though in the abstract they may appear to be directly incompatible.

On the other hand, they illustrate very forcefully the fact that the blind application of definitely stated rules is likely to work disaster. The importance of intelligently adapting the methods used to the conditions which have to be met in different fruit-growing regions is emphasized.

The differences in the conditions in the northern peach districts and in those met in connection with the investigations of the Missouri experiment station are largely differences in the climate during the winter season.

In the northern districts the normal winter is continuously cold and without any warm spells of sufficient duration to affect the dormancy of the trees. It usually remains cold until winter finally breaks. When it warms up enough to start the trees into activity and cause the buds to swell, there is comparatively little danger thereafter of serious frosts or freezes. Moreover, the critical factor—the one which largely governs the management of the orchard in the present connection—is low winter temperatures which are sufficient to kill the buds or injure the trees even when they are perfectly dormant. To best meet this low-temperature factor, it is recognized that the trees must be thoroughly dormant and the current season's growth well ripened.

In regions where the Missouri methods are applicable, critically low winter temperatures are of little concern, provided the trees are in a dormant state. But the winters are characterized by warm spells in December, January, and perhaps in February, which are sufficient to start the buds. This makes them tender and susceptible to injury later in the season by temperatures that are entirely seasonable and which would be of no concern to the peach grower if the buds were dormant. The trees often blossom early and before the season of spring frosts is past.

The reason for continuing the growth of the trees until late in the season in these regions is based on the fact, the practical importance of which is shown in the investigations referred to, that the rest period, or period during which the trees normally remain dormant, is one which by nature continues for a fairly definite period of time. Until that period is past, when once they have become dormant, the trees do not respond readily to temperatures which later would cause them to resume a more or less active condition and might result in the buds swelling enough to make them tender.

This is a matter that is relatively unimportant in regions where the entire winter season is normally characterized by temperatures which are not sufficiently high to affect vegetation, but it has a very important significance in the regions in which warm periods of considerable length occur during the winter If all the agencies which tend to stimulate the growth of the trees are discontinued relatively early in the season, the trees will cease growing and begin to ripen their wood at a correspondingly early date; the resting period inherently required by the trees is then completed early in the winter. If a spell of warm weather occurs soon after that period is ended, as, for instance, in January, the trees will respond to it; the buds will begin to swell and soon become tender. On the other hand, if the growth of the trees is continued actively by means of late tillage, nitrogenous fertilizers, or in other ways,

until the near approach of cold weather, the period of rest and dormancy inherently required by the trees is not completed until a correspondingly later time in the winter. Under these conditions the trees remain inactive during warm spells in December or January, and the buds do not swell enough to become tender until many of the dangers incident to adverse winter temperatures are past.

While the application of these methods, which have in view the results that follow the continuation of active tree growth until late in the season, may be somewhat restricted, they are undoubtedly worthy of the most careful consideration by peach growers who are located in regions where the winters are characterized by warm periods of sufficient length to cause the trees to become more or less active before settled spring conditions arrive.

There are a few special methods and practices in the management of peach orchards which are of sufficient importance in some sections to justify brief reference to them here.

The Ohio Agricultural Experiment Station has called attention to the efficacy of slightly mounding up the soil about the base of the trees in preventing injury during periods of excessively low winter temperatures. In the same connection it has been shown that various other factors relating to the soil may greatly influence the amount of damage which peach trees suffer during such periods.

The winter of 1903–4 was characterized in the Lake Erie peach district of Ohio by periods of severe and prolonged cold. Great numbers of peach trees were killed. The prevailing conditions and their attendant results on the peach trees are summarized as follows: [10]

> Exceptional causes of susceptibility to cold in rare cases of apparently healthy, vigorous trees: Low, moist, rich black soil which favored an extreme growth of soft, poorly ripened, or matured wood; or high culture upon soil rich in plant food which brought about similar results.
>
> The unusually deep, hard freezing of the earth's crust was due, directly, to the continued, steady cold, but was intensified, in many instances, by a lack of humus or vegetable matter in the soil, which constitutes nature's insulation of the surface of the earth from cold and heat.
>
> Providing that the orchards had been kept free from fungous disease and the San Jose scale by timely and thorough spraying, no injury of trees was found where stable or barnyard manure had been used upon the ground within the last year or two previous to the winter of 1903–4; rarely was an injured tree found standing in sod; no injury was done where the surface of the soil beneath the trees had been covered with even a very slight mulch; little injury was done where the trees stood in fairly well-drained soil containing a moderate amount of fertility and humus; no injury was found where the trees were under the grass-mulch method of culture . . .; no injury was observed in any case where the stems of the trees had been slightly banked or mounded with a few shovelfuls or forkfuls of soil, peat, or manure.
>
> Very few trees which, within the past few years, had been affected with leaf-curl or infested with San Jose scale or borers remained alive or uninjured; and very few trees existing upon infertile or exhausted soil, depleted of humus, escaped uninjured.

The usefulness of a cover crop in preventing the washing of the soil during the dormant period of the trees is frequently well demonstrated. Moreover, in some regions where the winters are rather severe and there is a very limited snowfall, a cover crop prevents the snow from blowing away, thus affording additional protection against the extreme freezing of the roots.

Another practice, which is entirely regional but which may be of considerable advantage at times, is the shading of the trunks of the trees with board protectors, lath screens, or in some other equally effective manner. This method is of use particularly in regions in which long periods of extremely hot weather usually occur and where the trees are not well shaded on the south and southwest sides. Shading in the manner suggested sometimes affords a measure of protection against the form of winter injury commonly called "sun scald." This is generally caused by too rapid thawing after the trunks have been frozen very hard.

[10] Ohio Agricultural Experiment Station Bulletin 157, "Winter-Killing of Peach Trees," p. 132.

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